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PHYSICS ABSTRACTS

SECTION A

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SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 1-682

VOLUME 58 **JANUARY 1955** NUMBER 685

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ETALLURGY Vacuum furnaces . . .
gassing . . . Melting . . . Gas-sampling.

EMISTRY Dehydration . . .
ncentration . . . Filtration . . .
tillation . . . Vacuum drying . . .
uum stills . . . Solvent recovery . . .

ECTRICAL Impregnation . . .
ing . . . Drying . . .

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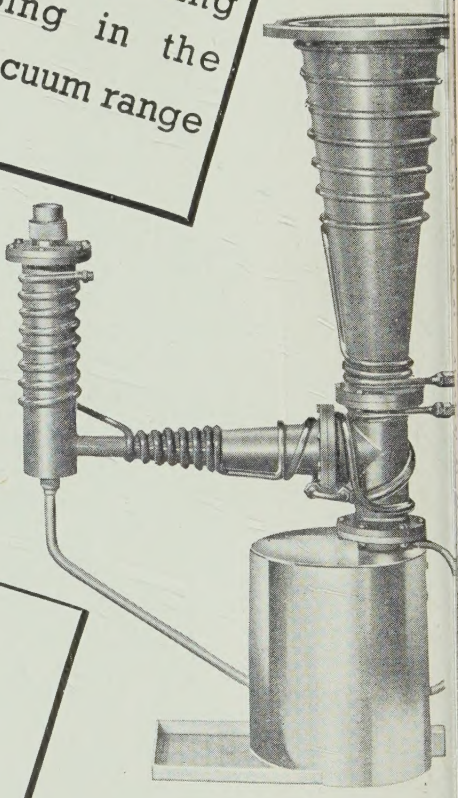

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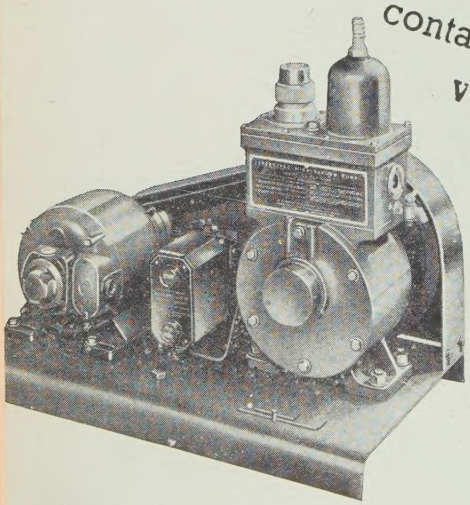

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplements published with the Indexes to Volumes 56 (1953) and 57 (1954). Reprints of the List of Journals (1953) and the Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Ann. sci. Ecole Normale Supér.	*Annales Scientifiques de l'Ecole Normale Supérieure.* Gauthier-Villars, Quai des Grands-Augustins 55, Paris.
Dep. Sci. Industr. Res. Forest Prod. Res. Spec. Rep.	*Department of Scientific and Industrial Research, Forest Products Research, Special Report.* Her Majesty's Stationery Office, Kingsway, London, W.C.2.
Elektron. Rdsch.	*Elektronische Rundschau.* Formerly *Funk und Ton.*
Elektrowärme	*Elektrowärme* [Beilage zu *Österreichische Zeitschrift für Elektrizitätswirtschaft*]. Springer-Verlag, Mölkerbastei 5, Vienna I.
Energia nucleare	*Energia nucleare.* Via Procaccini 1, Milan.
Proc. Instn Elect. Engrs Paper *Proc. Instn Elect. Engrs Monogr.*	*Proceedings of The Institution of Electrical Engineers, Papers and Monographs.* The Institution of Electrical Engineers, Savoy Place, London, W.C.2. Papers read at meetings, and Monographs, are published individually in advance of republication in the *Proceedings*; page numbers in *Proceedings* will be found in a later abstract.

Notes

Funk u. Ton	*Funk und Ton.* Title changed to *Elektronische Rundschau* [*Elektron. Rdsch.*] starting with January, 1955.
Trans Amer. Inst. Elect. Engrs	*Transactions of the American Institute of Electrical Engineers,* 33 West 39th Street, New York 18. Part I. Published bimonthly as *Communication and Electronics.* Part II. Published bimonthly as *Applications and Industry.* Part III. Published bimonthly as *Power Apparatus and Systems.*

Errata

Author Index (1953), p. 1203, column 2, line 23: *for* 381 *read* 831.
Abstr. 6745 (1953): insert N. DAVY as second author.
Abstr. 6577 (1954), line 2: *for* E. MENDOSA *read* E. MENDOZA.
Abstr. 6602 (1954), line 3: for *No.* 3–5 read *No.* 1–2.
Abstr. 9268 (1954), line 3: for (*July*, 1953) read (*Oct.*, 1953).
Abstr. 10009 (1954), line 7: *for* or vacuum *read* vacuum or.
Abstr. 11480 (1954), line 3: *for* 1302–10 *read* 1307–10.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 5897 (1953): **25**, *No.* 9, 924 (*Sept.*, 1954).
Abstr. 5376 (1954): **26**, *No.* 5, 871 (*Sept.*, 1954).
Abstr. 6602 (1954): **15**, *No.* 1, 55–6 (1954).
Abstr. 10347 (1954): **239**, *No.* 15, 925 (*Oct.* 11, 1954).
Abstr. 10445 (1954): **15**, *No.* 10, 698 (*Oct.*, 1954).
Abstr. 11279 (1954): **15**, *No.* 10, 704 (*Oct.*, 1954).

MATHEMATICS 51

517.949

1. Analysis of systems involving difference-differential equations. T. M. BURFORD. *J. appl. Phys.*, **25**, *No.* 9, 1145–8 (*Sept.*, 1954).

It is known that many physical systems, both time- and space-dependent, are described by difference-differential equations. Although the exact solutions to such equations are known to be unique, their determination usually involves a segmented type of solution that is very laborious to obtain. An approximate method of determining any number of roots is described. This approximate procedure allows forward gain and delay to be freely chosen and gives immediately the maximum stable value of forward gain. In many cases, especially where an optimum value of damping constant or forward gain is to be found, it appears that this approximate procedure is more easily applied than any previously described method. A.

518.4

2. Simplified particle-size calculations. C. H. LEIGH-DUGMORE. Letter in *Nature* [*London*] **174**, 567 (*Sept.*, 1954).

A simple graphical method is outlined, using log. probability paper. Estimates of the mean and standard deviation of the distribution of sizes can be quickly read off. The method is best used as a rough check on calculations made by a longer method, or for obtaining quickly approximate information.

L. S. GODDARD

518.5

3. Programme design for the C.S.I.R.O. Mark I computer. III. Adaptation of routines for elaborate arithmetical operations. T. PEARCEY and G. W. HILL. *Austral. J. Phys.*, **7**, *No.* 3, 485–504 (*Sept.*, 1954).

For Pt II, see Abstr. 4 (1954). These facilitate the use of the machine for performing operations required for extended accuracy, floating index and complex variable arithmetic. Programming for such operations is greatly simplified by the use of an "interpretive" code, especially chosen by the programmer. The "interpretive" method of programme design is potentially very powerful, and relieves the programmer of the work associated with the details of store positioning, index control, scale changes, etc. The various operations called into use by the specially chosen codes are closely analogous to the operations existing in the normal machine code, although some are specially chosen to facilitate the use of variable commands and in transfers of control by linkage and in control of repetitions of routines which are stored in the machine in the special code. A.

518.5

4. The effect of interpretive techniques on functional design of computers. T. PEARCEY, G. W. HILL AND R. D. RYAN. *Austral. J. Phys.*, **7**, *No.* 3, 505–19 (*Sept.*, 1954).

An analysis of the programmes for a number of computations performed by the C.S.I.R.O. Mark I computer shows that a great proportion of store space and operating time is occupied by the control of the course of the calculation, and that the proportion of the store space required as working space by a programme decreases as the size of the programme increases. The increasing use and great flexibility of interpretive techniques suggests that a very flexible, reliable computer, easy to use, could be constructed. Such a computer would possess only a relatively small amount of rapid-access erasable store, and a larger amount of rapid-access non-erasable store, in which would be held all interpretation routines, function blocks, and so on. The operator would require no knowledge of the actual machine code, but would place his hyper-programmes and data into a slow-speed backing store. A.

518.5

5. Relay time-division multiplier. G. A. KORN AND T. M. KORN. *Rev. sci. Instrum.*, **25**, *No.* 10, 977–82 (*Oct.*, 1954).

Describes the theory and design of a new low-cost analogue multiplier suitable for use with the d.c. analogue computers now widely applied as differential analysers and equation solvers. The new multiplier comprises a simple relay circuit utilizing the time-division principle. The multiplier accepts input voltages of both signs and is capable of multiplication to within an accuracy of 3·5% of full scale at zero frequency and 7% of full scale through the frequency range between 0 and 10 c/s. Greater accuracy is possible through sacrifices in the useful frequency range. The dynamic range of input and output voltages is −80 V to +80 V. The multiplier circuit proper contains no vacuum tubes, servomechanisms, or power supplies but utilizes one of the operational amplifiers of the d.c. analogue computer with which it is used. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

523.11 : 523.841.11

6. Methods for determining the absolute values of extra-galactic distances. F. ZWICKY. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 9, 610–11 (*Aug.* 30, 1954) In French.

The development of methods based on standard lengths, to replace the existing relative criteria derived from variable-star data, is discussed. Observations of the gas-cloud expelled at the initial explosion of a supernova yield two parameters in terms of a standard length, viz. $L_1 = ct$, and $L_2 = vt$, where c is the velocity of light and v the velocity of the expanding cloud, t being the time elapsed since the epoch of the initial explosion. If the true distance of the supernova

is D, and the associated cloud extends earthward to a distance, d, observations of the changing angular diameter, Δ, of this cloud will serve to determine both D and d. Further, an independent check on D is possible from observations of the intensity and polarization of the light scattered by the cloud. A third method utilizes the quantity, L_2, as a standard length; an example of this is quoted, based on data for the 1885 supernova, Messier 31 in Andromeda.

D. R. BARBER

523.112 : 530.12

7. Recession of the galaxies in Eddington's theory. N. B. SLATER. *Nature* [*London*] **174,** 321–2 (*Aug.* 14, 1954).

A correction found necessary in the formula $R_0/\sqrt{N} = 2\sigma$ [*Fundamental Theory*, p. 6] replaces 2σ by 3σ. This has the effect of multiplying the estimated recession factor by 4/9 and is consistent with Baade's modifications of galactic distances which involve a halving of the recession factor. The amended formula does not affect the calculated values of microphysical constants but spoils the agreement of N with the theoretical value. R. A. NEWING

523.112 : 530.12

On linear field theory. An action principle and its application in cosmology. *See Abstr.* 29

523.161

8. Interaction of dusty and gaseous interstellar matter. V. I. KRASOVSKIĬ. *Dokl. Akad. Nauk, SSSR.*, **92,** *No.* 5, 907–10 (1953) In Russian.

Discusses the effect of the concentration of interstellar dust on the ionization and dissociation of interstellar gas. The neutralization of H II can occur as a result of collision either with electrons or with (neutral or charged) dust particles. These particles in a heated ionized interstellar gas, which consist, e.g., of Si or Fe oxides, are probably covered with a thin layer of the reduced element, owing to the (chemical) adsorption of atomic H. In the conditions of interstellar space, each collision between H and a dust particle carrying adsorbed H atoms will result either in formation and evaporation of H_2 or in adsorption of H in the holes of the monatomic Si (Fe) film. In cold interstellar gas ($\sim 100°$K), a recombination of this kind will only occur with very few atoms whose energy E exceeds $10\,k/T$. Hence a relatively large-scale formation of molecules on dust particles is only possible in regions with a high-density or high-temperature gas, but it is not possible in cold and rarefied gas. The energy of each dust particle is probably higher than the mean kinetic energy of molecules of the surrounding gas. In the vicinity of hot stars, where there is little dust matter, it is the electrons that are mainly responsible for the neutralization of H II, and the radio-temperature of H I can be higher than in regions with much dust. The distribution and composition of interstellar dust should vary in the cosmic space according to differences in the light and electron pressures.

F. LACHMAN

523.162.2

9. Light scattering and Hubble effect. T. NEUGEBAUER. *Acta phys. Hungar.*, **4,** *No.* 1, 31–48 (1954) In German.

The possibility of explaining the red-shift in terms of electron scattering is examined in detail and the estimated effect is found to be too small. The possibilities of neutrino scattering and of photon–photon collisions are discussed in a qualitative manner.

R. A. NEWING

523.165

10. Methods and results of radio astronomy. H. SIEDENTOPF. *Z. angew Phys.*, **6,** *No.* 8, 376–84 (*Aug.*, 1954) In German.

A statement of the fundamental principles of the observation of radio radiation by the pencil-beam and interferometric methods, a summary of the observations of thermal emission from the solar corona and of the variable solar radiation, and a brief discussion of the relationship between the discrete sources and classes of astronomical objects observed optically. M. W. OVENDEN

523.165

11. Radio emission from the Andromeda nebula. J. E. BALDWIN. Letter in *Nature* [*London*] **174,** 320–1 (*Aug.* 14, 1954).

The distribution of brightness across the Andromeda nebula along various axes on 3·7 m using variable-spacing interferometers has been measured. The observed distribution is compared with the optical emission and mass distribution across the nebula, and with a model similar to that of Westerhout and Oort for our own galaxy. There is an indication of an approximately spherical population of radio stars extending to radial distances exceeding 10 000 parsecs, which contributes about two-thirds of the total intensity. A similar population of radio stars in our own galaxy might explain the "isotropic" component of cosmic radio emission.

M. W. OVENDEN

523.165

12. Galactic absorption of radio waves. J. P. HAGEN AND E. F. MCCLAIN. Note in *Astrophys. J.*, **120,** *No.* 2, 368–9 (*Sept.*, 1954).

Comparison of a band about 1·5 Mc/s wide, and a band 3·25 Mc/s distant, centred on the maximum of the 21 cm line, and of width about 55 kc/s, while the aerial sensitivity pattern is swept through the position of a discrete radio source gives clear evidence in several cases (including the Crab nebula) of selective absorption of the neutral hydrogen line in the direction identified as the radio source. Detailed observations are given for the source NRL 5, a source some ½° in diameter, close to the galactic centre and superimposed upon a wider source, NRL 9. The possible nature of these sources is briefly discussed.

M. W. OVENDEN

523.165

13. Observations of cosmic noise at 9·15 Mc/s. C. S. HIGGINS AND C. A. SHAIN. *Austral. J. Phys.*, **7,** *No.* 3, 460–70 (*Sept.*, 1954).

From observations made at a frequency of 9·15 Mc/s, with an aerial of beam width 29° between half-power points and directed to Dec. −32°, a curve of equivalent aerial temperature, as a function of sidereal time, is derived. The temperatures observed were of the order of 10^6 ° K. The curve is compared with curves derived for similar conditions by calculation from the results of observations at 18·3 Mc/s

and at 100 Mc/s. It is found that the equivalent temperatures increase rapidly with decreasing frequency, but the ratio of maximum to minimum temperature decreases with frequency. It is shown that "atmospheric" noise levels observed by the standard techniques sometimes contain a large contribution from cosmic noise at this frequency. A.

523.5

14. Radio observations of meteors. P. M. MILLMAN. *Science*, **120**, 325–8 (*Aug.* 27, 1954).

A brief summary of the most significant observational results secured through radar observations of meteors during the last seven years.

M. W. OVENDEN

523.72

15. Harmonics in the spectra of solar radio disturbances. J. P. WILD, J. D. MURRAY AND W. C. ROWE. *Austral. J. Phys.*, **7**, *No.* 3, 439–59 (*Sept.*, 1954).

Describes observations with a 40–240 Mc/s radio spectroscope leading to the discovery and preliminary investigation of harmonics in the spectra of sporadic bursts from the sun. It is found that spectral features of bursts are commonly duplicated with a 2 : 1 frequency separation. The ratio is sometimes appreciably lower though apparently never greater. This and other features of the spectra are shown to support the hypothesis that the fundamental frequency corresponds to the natural plasma frequency of the corona in the vicinity of the source. By applying this result to a standard model of the corona, information on the position, velocity, and size of the sources is deduced. The results suggest that the generation of bursts may be associated with longitudinal plasma oscillations excited by fast streams of charged particles. A.

523.852.3

16. The law of red-shifts. E. HUBBLE. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 6, 658–66 (1953).

After a review of observations made prior to the completion of the 200-inch telescope a detailed account is given of work being done in revising the distance scale, in setting up faint magnitude sequences and in the measurement of nebular magnitudes. Recent observations, based on the 10th nebula in a cluster as distance indicator, can be represented to a very close approximation by the linear relation $\log_{10}(c.d\lambda/\lambda) = 0{\cdot}2m_{pv} + 1{\cdot}16$, where magnitudes have been corrected for the energy effect but not for recession. R. A. NEWING

523.872

17. A study of the continuous radiation from Wolf-Rayet stars in the Cygnus region. Application to the determination of distances and colour-temperatures. Y. ANDRILLAT. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 6, 480–3 (*Aug.* 9, 1954) In French.

Eight W–R spectra have been studied quantitatively in the 2 spectral regions, 3900–4900 Å, and 5900–7900 Å by photographic photometry. The two regions are affected differently by interstellar absorption; but, with a knowledge of the interstellar absorption curves at these wavelengths in the direction of the stars, a method is developed which allows of a corrected distance determination, and also an evaluation of colour-temperature. Results for the 8 stars are tabulated. D. R. BARBER

523.877

18. Problem of stationary motion in a radiating gaseous layer. W. POGORZELSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 1, 7–8 (1954) In French.

Velocity $u(x)$ and gravitational field $g(x)$ are assumed perpendicular to the plane boundaries $x = 0$ and $x = a$ of the layer and conditions are assumed given at $x = 0$. A system of nonlinear integral equations is set up for density and temperature. R. A. NEWING

523.877 : 532.5 : 536.25 : 538.65

19. Problems of stability in hydrodynamics and hydromagnetics. S. CHANDRASEKHAR. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 6, 667–78 (1953).

A review of recent work by the author on problems of gravitational and of thermal stability in the presence of magnetic fields and Coriolis forces.

R. A. NEWING

523.877 : 539.17

20. Electron screening and thermonuclear reactions. E. E. SALPETER. *Austral. J. Phys.*, **7**, *No.* 3, 373–88 (*Sept.*, 1954).

In the interior of stars most atoms are ionized, but the electrostatic potential of a bare nucleus induces a spherically symmetric polarization of the surrounding electrons and nuclei. The effect of this screening charge cloud on the rate of thermonuclear reactions is investigated for the case of complete ionization of all atoms. The charge distribution and potential of the screening cloud is calculated for two limiting cases where the electrostatic interaction energy between neighbouring nuclei is small or large compared with the thermal energy (weak or strong screening). The charge cloud is also investigated for intermediate strength of screening, for nuclear species which are rare and have a large charge. Under most stellar conditions the impact parameter for a thermonuclear collision is much smaller than the radius of a screening cloud. For such cases, a simple formula is given relating the increase in the reaction rate to the potential of the screening cloud. Numerical values are presented for a few typical reactions. For conditions typical for the interior of ordinary main sequence stars the increase in the reaction rate is fairly small, usually less than a factor of two. A.

529.786

21. Atomic clocks and frequency standards on an ammonia line. II. K. SHIMODA. *J. Phys. Soc. Japan*, **9**, *No.* 4, 558–67 (*July–Aug.*, 1954).

For Pt I, see Abstr. 8885 (1954). The accuracy of any atomic clock so far constructed has been much worse than theoretically expected. The use of Zeeman and Faraday effects is examined for eliminating causes of errors discussed in Pt I. An atomic or molecular system in a magnetic field violates the reciprocity theorem. A method is proposed and investigated to utilize the unreciprocal component of transmission characteristics of the absorption cell, though it proved to be not so useful as expected. And the character of a circular waveguide absorption cell in an axial magnetic field is treated in detail as a

preparation for designing a high-precision atomic clock. A.

529.786

22. Atomic clocks and frequency standards on an ammonia line. III. K. SHIMODA. *J. Phys. Soc. Japan*, **9**, *No.* 4, 567–75 (*July–Aug.*, 1954).

The design and construction of a high precision atomic clock is described. The device effectively employs Stark-, source- and Zeeman-modulation, and is free from the errors caused by reflections in the microwave line. Zeeman splitting nearly equal to the line width is preferable. The preliminary result with one metre cell-length and an unsatisfactory Stark modulator has shown that the device is successful and that an accuracy of 10^{-9} or better is obtainable. Measurements of the line width and the analysis are also given. A.

PHYSICS 53

53.081

23. Account and criticism of Professor Max Landolt's "Théorie des Grandeurs." M. ESKENAZI. *Istanbul Tek. Üniv. Bult.*, **5**, 17–26 (1952) In French.

A résumé is given of the mathematical operational method applied to physical quantities which Landolt develops in his book *Grandeur, Mesure et Unité* (Paris, 1947). It is maintained that the axioms adopted have no physical content and thus the conclusions arrived at from the various theorems are unjustifiably extended beyond their range of validity. S. WEINTROUB

FUNDAMENTALS 530.1

530.112

24. Proposal for a new aether drift experiment. L. FURTH. Letter in *Nature* [*London*] **174**, 505–6 (*Sept.* 11, 1954).

It is emphasized that the author's suggested experiment [Abstr. 3053 (1954)] involves standing waves. The frequency fluctuations of a fixed cavity resonator could give information about an aether drift, but it would be difficult to keep the system free from disturbances for a sufficient time. R. A. NEWING

530.12

25. On the influence of the expansion of space on the gravitational field surrounding an isolated body. F. A. E. PIRANI. Note in *Proc. Cambridge Phil. Soc.*, **50**, *Pt* 4, 637–8 (*Oct.*, 1954).

The Einstein–Straus discussion of this problem (1945) is modified by taking the cosmological constant to be non-zero. It is then found that the gravitational field is influenced by expansion and that this factor must be included when considering the dynamics of the local cluster of nebulae. R. A. NEWING

530.12

26. Application of the general solution of the equations $g_{\mu\nu\underset{+-}{\rho}} = 0$ to the determination of a particular affine connection. M.-A. TONNELAT. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 3, 231–3 (*July* 19, 1954) In French.

Spherically symmetrical solutions for the static and non-static cases are deduced from the general solutions of the equations [Abstr. 6267 (1952)] and are discussed. G. FIELD

530.12

27. The choice of the metric and electromagnetic field in Einstein's unified theory. S. MAVRIDÈS. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 10, 637–40 (*Sept.* 6, 1954) In French.

Continuation of previous work. See Abstr. 7106 (1954).

530.12

28. Inertia of energy. W. KANTOR. *Amer. J. Phys.*, **22**, *No.* 8, 528–41 (*Nov.*, 1954).

The principle of the inertia of energy is a conclusion of the relativity theory that has far-reaching consequences, in that it consolidates the laws of conservation of mass, momentum and energy into one conservation expression. A brief historical discussion of the conservation laws and of the classical concept of the flow of energy is followed by several mathematical derivations and interesting examples of the inertia of energy. Where possible an heuristic approach is used. A.

530.12 : 523.112

29. On linear field theory. I. An action principle and its application in cosmology. W. SCHERRER. *Z. Phys.*, **139**, *No.* 1, 44–55 (1954) In German.

An action function introduced previously [Abstr. 9908 (1954)] is generalized and expressed as the sum of 6 invariants which are homogeneous quadratic functions of the field quantities. Two types of variation are considered: in "free" variation, the matrix coefficients $\psi_{i,k}$ of the linear differential forms are kept fixed, and in "conditioned" variation the supplementary condition $\delta \int |\psi_{i,k}| dx = 0$ is introduced. The theory is applied to space-time in the case of a spherically symmetric line element, and the cosmological models arising from the two types of variation are discussed. The latter variation includes a case similar to the Friedman–Einstein solution for zero cosmological constant and leads to an estimated age of $4 \cdot 1 \times 10^9$ years. R. A. NEWING

530.12

30. The problem of "equivalent" potentials in classical equations of motion. J. WERLE. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 7, 281–5 (1953).

By introducing a modified potential V in the non-relativistic equation of motion of a particle in a static potential, many relativistic effects in the description of its orbit can be accounted for. V can be deduced by comparing the relativistic and non-relativistic Hamilton–Jacobi equations. The method is illustrated by a discussion of the motion in a Coulomb and Yukawa potential. G. FIELD

530.12 : 530.145.6

31. Space-time representation in wave mechanics: illustration of the method. M. K. BRACHMAN. *Phys. Rev.*, **96**, *No.* 2, 516–18 (*Oct.* 15, 1954).

The basic equations of a new space-time representation are derived in an heuristic fashion, and a simple application is presented to illustrate the point of view. A.

530.12 : 538.3

32. Elementary derivation of Hlavatý's canonical forms for the electromagnetic tensor in unified field theory. A. W. SÁENZ. *Z. Phys.*, **138**, *No.* 5, 489–98 (1954) In German.

The skew part $k_{\mu\nu}$ of $g_{\mu\nu}$ can be expressed at each point of space-time in one of four mutually exclusive canonical forms. This result is established by elementary methods for the case in which the symmetric part of $g_{\mu\nu}$ defines Minskowski space-time. $k_{\mu\nu}$ is then identified with the electromagnetic tensor and the canonical forms are shown to be the Lorentz equivalents of the following fields: (i) **E** and **H** parallel and non-zero; (ii) $\mathbf{E} \neq 0$, $\mathbf{H} = 0$; (iii) $\mathbf{E} = 0$, $\mathbf{H} \neq 0$; (iv) **E** and **H** orthogonal and of equal magnitude. R. A. NEWING

530.145

33. Action as coordinate of space. VIII. YU. B. RUMER. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 33–46 (1953) In Russian.

For Pt VII, see Abstr. 2925 (1953). The relation between 5-optics and the theory of pseudovector and pseudoscalar mesons, and of particles with spin 2, is explained. Whereas the contemporary theories describe the motion of elementary particles by relativistically invariant wave equations, the author shows that, at least where particles with whole spin are considered, Ginzburg's relativistic non-invariant calibration may be regarded as equally satisfactory as the relativistically invariant calibrations yielding relativistically invariant wave equations. In electrodynamics Ginzburg's representation is useful for dealing with photons, and in the theory of a weak gravitational field, for dealing with gravitons. In 5-optics where the sharp distinction between neutral particles with zero rest mass and charged heavy particles is effaced and their behaviour is represented by the same unique formalism, Ginzburg's calibration deserves preference. B. F. KRAUS

530.145

34. Action as coordinate of space. IX. YU. B. RUMER. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 303–11 (1953) In Russian.

A general demonstration is presented of the equivalence of the ordinary 5-dimensional tensor analysis and of the *D*-formalism generally used in quantum mechanics, according to which the consideration of the external electromagnetic field in the wave equations for the elementary particles is obtained by the replacement of the operators $\partial/\partial x^k$ by operators $D_k = (\partial/\partial x^k) + (ie/\hbar c)A_k$. The demonstration is formally based on the introduction of a metric into the Riemann 5-space by means of the metric matrix of Lamé. The paper deals with the special case that the external field is purely electromagnetic. Furthermore a harmonic coordinate system in 5-space is assumed, i.e. that the potentials g_i are normed according to Lorentz, $\partial g_i/\partial x^i = 0$, and that their periodic dependence on the action coordinate is neglected (equivalent to the condition of cylindricity $\partial g_i/\partial x^5 = 0$). Invariant *D*-differentiation is explained and the equations of the meson field are given, the case of the spinor field being briefly discussed. This is described by Dirac's equation with an additional term, a tentative explanation of which is presented. B. F. KRAUS

530.145

35. On non-local fields. G. WATAGHIN. *Nuovo Cimento Suppl.*, **12**, *No.* 1, 103–6 (1954) In Italian.

A distinction is made between (i) non-local interaction between fields and (ii) proper non-local fields. An example is given of the method of non-local interaction. The method of non-local fields is more general and includes the former. It is relevant in the problem of the quantization of mass [see Abstr. 7448 (1953)]. L. S. GODDARD

530.145

36. On the Coulomb and Hulthén potentials. S. T. MA. *Austral. J. Phys.*, **7**, *No.* 3, 365–72 (*Sept.*, 1954).

Contains the results of two investigations. (i) The Hulthén potential is considered as a modification of the Coulomb potential. The transition from the former to the latter is investigated. (ii) The zeros of the Fredholm determinant for the Hulthén potential are calculated from the first two terms of its power-series expansion. These approximate results are compared with the exact values. A.

530.145

37. General theory of propagators. I. H. UMEZAWA AND A. VISCONTI. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 12, 690–2 (*Sept.* 20, 1954) In French.

Propagators carrying n electrons (or p photons) from one space-time surface to another can be defined by the dependence of the evolution operator on fictitious external sources, i.e. by using the evolution operator as a generating function. G. E. BROWN

530.145

38. Radiative effects in a constant field. R. G. NEWTON. *Phys. Rev.*, **96**, *No.* 2, 523–8 (*Oct.* 15, 1954).

A method of avoiding all infrared divergencies in the radiative effects of a constant electromagnetic field is developed. It is used, without the necessity of resumming a non-integrable series, to calculate the one photon mass operator up to the third order in the external field. The magnetic susceptibility and field dependence of the rest mass of an electron are thereby exhibited to lowest order. The result is then shown in a simple way to provide charged particles with strong short-range forces against the Coulomb field. Particles of unrealistically small mass and charge would carry a large repulsive core, if Coulomb attractive, or a large attractive shell, if Coulomb repulsive. A.

530.145

39. The bringing of the product of operators to canonical form in the theory of second quantization. V. L. BONCH-BRUEVICH AND B. V. MEDVEDEV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4(10) 410–16 (1953) In Russian.

In applying the method of second quantization to

a number of problems [Abstr. 2366, 6210 (1951), 3075, 7929 (1952)] it was necessary to consider operators, consisting of a product of a number of creation and annihilation operators. The bringing of the product of 2 such operators to canonical form (all elementary creation operators to the left of all annihilation operators) is necessary, e.g. in the evaluation of commutators. This question has been discussed by Wick [Abstr. 853 (1950)], but in the present paper the explicit formulae for the coefficients which achieve the transformation are derived, both for bosons and fermions. It is mentioned that the method can be generalized to the case when the non-vanishing commutators or anticommutators of the elementary creation and annihilation operators are functions more general than the usual δ-functions.

W. J. SWIATECKI

530.145

40. Quantum electrodynamics in configuration representation. IV. Relativistic equation for the electron-positron system. K. A. TUMANOV AND YU. M. SHIROKOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 369–74 (1953) In Russian.

For Pt III, see Abstr. 9927 (1954). A single-time equation describing positronium valid to order $\alpha = e^2/hc$ is derived. A non-relativistic approximation to this equation is obtained by expanding in v/c and keeping terms to order v^2/c^2. G. E. BROWN

530.145

41. On the self-dispersal of charge under the action of its own field. M. S. NATANZON. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4(10) 448–54 (1953) In Russian.

In view of the results of Abstr. 5512 (1950) in which the stability of charge distributions with definite form factors was demonstrated, the question is treated generally for any form factor in the framework of the theory of a classical electron. Starting from the Maxwell–Lorentz equations, the variations associated with a small change in the charge distribution are written down. A characteristic equation results, the analysis of whose roots leads to the conclusion that for real masses self-dispersal of charge would not take place, independently of the form factor.

W. J. SWIATECKI

530.145

42. Generalized method of calculation of damping in the quantum theory of fields. V. I. GRIGOR'EV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1(7) 40–50 (1953) In Russian.

The theory of Sokolov [*Journal of Physics, USSR*, **5**, 231, 1941] is used as a starting point. Contrary to the usual calculation of non-stationary processes by the variation of constants method, the amplitude of the initial state depends on time so that the sum of the squares of all amplitudes is always unity; since this method furnishes the classical radiation resistance, it is termed a "theory with calculation of damping." The process of absorption and emission of photons is considered in detail. The equations are cast into a form employing only amplitudes $C_k^{(i,j)}$, describing an electron in state k after absorption of i photons and emission of j photons. Modification of usual formulae occurring in non-stationary processes are considered (scattering cross-sections at high energies are made finite, etc.). G. E. BROWN

530.145

43. On the question of the role of damping in the theory of bound particles. V. I. GRIGOR'EV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1(7) 51–6 (1953) In Russian.

The scattering of photons by an electron bound in an atom is considered. The perturbing term from the electromagnetic field is transformed into a term giving immediately second-order processes. The equations for the amplitudes of various states are obtained, in the usual way as in the variation of constants method, but the amplitude of the initial state as well as of other states is taken to be time-dependent (see preceding abstract). The level broadening and an effective displacement come from the calculation. These quantities are also briefly discussed for spontaneous collisions. G. E. BROWN

530.145

44. On renormalization in quantum electrodynamics. E. S. FRADKIN. Letter in *Zh. éksper. teor. Fiz.*, **26**, *No.* 6, 751–4 (1954) In Russian.

Schwinger's functional form of quantum electrodynamics is renormalized by defining the usual Z-factors by requiring that certain general conditions are satisfied: (1) The particle propagator has a pole of 1st order for $p_\mu\gamma_\mu = m_{\text{exp.}}$ (2) The photon function $D'(k) \to 1/k^2$ for $k^2 \to 0$. (3) The vertex function $\Gamma'_\mu(m, m, 0) = \gamma_\mu$. With the Z-factors so determined, the theory yields finite results in any order if expanded in powers of the coupling constant; the preceding definitions are independent of such an expansion.

G. E. BROWN

530.145

45. A note on the generalized statistics. F. FERRARI AND C. C. VILLI. Letter in *Progr. theor. Phys.*, **11**, *No.* 3, 328–9 (*March*, 1954).

A generalized exclusion principle is taken as basis of a statistical framework in which a state is to be occupied by a given number of particles. Such statistics are assumed to be associated with representations of the symmetric group. Possible applications to assemblies of strongly interacting particles are discussed. G. FIELD

530.145

46. On the representation of particles interacting with external fields by wave-functions with singularities, which are localized and movable along trajectories. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 4, 344–6 (*July* 26, 1954) In French.

A method is given for finding such functions for a single particle. Complete solutions are obtained for a particle in a constant electric field, and for the harmonic oscillator. See also Abstr. 7117–18, 8900 (1954). F. ANSBACHER

530.145 : 538.3

47. On the motion of space charges according to Dirac's theory. G. HÖHLER. Note in *Z. Naturforsch.*, **9a**, *No.* 7–8, 696 (*July–Aug.*, 1954) In German.

Infeld's discussion [Abstr. 3070 (1954)] of the motion of a charge cloud is examined in relation to the equivalence established by the author [Abstr. 5091 (1952)] between the Dirac and Maxwell–Lorentz theories for continuously distributed charge.

R. A. NEWING

530.145

48. On a non-linear quantum theory of the electron. D. D. Ivanenko and A. M. Brodskiĭ. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 383–8 (1953) In Russian.

A non-linearity of the type $j_\mu(x)j_\mu(x)$ is added to the Lagrangian for the electron field in interaction with radiation, given in the Heisenberg representation. A canonical transformation removes the above term and the ordinary non-linear term $A_\mu(x)j_\mu(x)$. The transformed equations obey free-field equations. The introduction of the non-linear term has thus simply changed the S-matrix and transitions between various free-field states are produced by it. The non-linearity leads to a renormalization of mass, but it is not shown that a finite rest mass can be obtained. G. E. BROWN

530.145

49. Further comments on the proposed mass spectrum. S. Yoshikawa and T. Hasebe. Letter in *Progr. theor. Phys.*, **11**, *No.* 4–5, 496–8 (*April–May*, 1954).

See Abstr. 7122 (1954).

530.145

50. On a theory of interaction of nucleons and mesons. V. P. Silin. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 389–96 (1953) In Russian.

The method of Tamm is used to describe the system of nucleon + one pseudoscalar π-meson with pseudoscalar coupling. Nucleon recoil is neglected and angle variables are separated out. In this approximate treatment the interaction vanishes except in P states. It is shown that the high momentum components of the wave-function of this system do not cut off sufficiently rapidly to give a finite energy. G. E. BROWN

530.145

51. New approach to the question of the influence of relativistic terms in the meson theory of nuclear forces. I. I. Verle [J. Werle]. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1(7) 19–35 (1953) In Russian.

The meson field is expanded in terms of its time derivatives as

$$\phi = \sum_{l=0}^{\infty} \phi^{(2l)}$$

where $\phi^{(2l)}$ is the $2l$th time derivative of ϕ_0. A system of equations

$$(\nabla^2 - \mu^2)\phi^{(0)} = -\gamma\pi\Omega\delta(x - x_i)$$
$$(\nabla^2 - \mu^2)\phi^{(2)} = \ddot{\phi}^{(0)}$$
$$\cdots\cdots\cdots$$
$$(\nabla^2 - \mu^2)\phi^{(2l+2)} = \ddot{\phi}^{(2l)}$$

is then solved by iteration. Here Ω is the meson-nucleon interaction. The connection between the classical and quantum-mechanical approaches can be made with proper prescriptions, e.g. time derivatives in the above sense are replaced by commutators with the Hamiltonian in quantum mechanics. A brief description of this work has been given in English (see abstract following). G. E. BROWN

530.145

52. An application of a new approximation method to quantum calculations in the meson theory of nuclear forces. J. Werle. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 5, 173–6 (1953).

A short summary of work reported in a paper in Russian (see abstract preceding). G. E. BROWN

530.145

53. On the expansion parameter in pseudoscalar meson theory with pseudoscalar coupling. A. D. Galanin. *Zh. éksper. teor. Fiz.*, **26**, *No.* 4, 417–22 (1954) In Russian.

The simple, second-order (in g) self-energy, vacuum polarization and vertex graphs are investigated in the cases of low momentum and high momentum. The second and third graphs are found to have a factor $(\mu/m)^2$ multiplying g^2, where μ is the meson mass and m is the nucleon mass, in the low momentum limit. In the extreme relativistic region, all three go roughly as $g^2 1n(E/m)$. The behaviour of the propagator is investigated in the extreme relativistic region by including a special set of radiative corrections, i.e. the "ladder" self-energy graphs; and the vertex part, by including all vertex graphs with uncrossed meson lines. In the former case, the free particle propagator is multiplied by $(p^2/m^2)^{g^2/8\pi}$, whereas the vertex part behaves as $(p^2/m^2)^{g^2/4\pi}\gamma_5$. The latter result is sensitive to the particular variant of the theory employed, which is the neutral theory here. G. E. BROWN

530.145

54. Some remarks on the infinities in the theory of the pseudoscalar meson with pseudovector coupling. A. D. Galanin. *Zh. éksper. teor. Fiz.*, **26**, *No.* 4, 423–9 (1954) In Russian.

The propagators S' and D' are employed in approximate form, taking into account self-energy parts in which one meson, and one nucleon bubble, occurs respectively, instead of S and D. The propagators S' and D' are not, however, expanded in a power series in the coupling constant f. Calculation results in D being represented as $-(3\pi\mu^2/f^2)(k^2-\mu^2)^{-1}(k^2-\mu'^2)^{-1}$ where μ', the factor multiplying the term which is essentially D, is f-dependent. Employing this D' in the nucleon self-energy graph yields renormalizable results to order f^2. The vertex graph is also calculated to lowest order. A perturbation expansion, however, indicates that graphs with two mesons in the air simultaneously are as important as those considered above and that the ratio of "2-meson" to "1-meson" terms is not dependent on f. Consequently, either the above procedure is not consistent, or perturbation theory in this latter estimate is not reliable. G. E. BROWN

530.145

55. Description of the interaction of a system of particles with the electromagnetic field. Yu. K. Khokhlov. *Zh. éksper. teor. Fiz.*, **26**, *No.* 5, 576–84 (1954) In Russian.

The interaction is formed in terms of the field strengths, independent of the gauge of the potential. Electric and magnetic multipole moments are defined as operators through which the energy of the system in an electromagnetic field is expressed. Formulae for multipole radiative transitions are given, and the independence of electric moments from exchange force in the nucleus is discussed. G. E. BROWN

530.145

56. On the influence of the pulsations of the meson cloud of the nucleon on the probability of interaction of particles. G. A. Askar'yan. Letter in *Zh. éksper. teor. Fiz.*, **26**, *No.* 6, 751 (1954) In Russian.

Neutrons in transition between states with no

meson and with mesons bound to them are described by pulsating disks. Experimental results then give an estimate (~35%) of the probability of mesons being present in the cloud. G. E. BROWN

530.145

57. On the question of meson-nucleon interactions. D. A. KIRZHNITS. *Zh. éksper. teor. Fiz.*, **27**, *No.* 1(7) 6–18 (1954) In Russian.

A new type of interaction, $\delta S = -i\int \psi^+\{ik\phi\mu_5\gamma_i\nabla_i\}\psi d^4x$, is proposed and shown to satisfy all of the usual general conditions on interactions between the meson field ϕ and nucleon field ψ, except that it violates relativistic requirements in very small regions near the sources of ϕ. This interaction is non-gauge invariant and consequently, would not enter in electrodynamics. The physical effects of this added "impulse" interaction are to endow the nucleon with a ϕ-dependent mass which increases with (external) attractive force and thus acts as a repulsive force of an inertial type. G. E. BROWN

530.145

58. On the weak universal boson-fermion interaction. S. OGAWA, H. OKONOGI AND S. ÔNEDA. Letter in *Progr. theor. Phys.*, **11**, *No.* 3, 330–2 (*March*, 1954).

π°-meson interactions with leptons and heavy particles, and θ_0-meson–lepton interactions are investigated. Their consistency with other processes, such as β-decay, μ-capture by nuclei and Λ°-decay, is shown. G. FIELD

530.145

59. The effect of the mass difference between charged and neutral pions on the nuclear force. A. SUGIE. Letter in *Progr. theor. Phys.*, **11**, *No.* 3, 333–4 (*March*, 1954).

Taking account of the mass difference destroys the charge independence of the nuclear force. The charge-dependent term in p.s.–p.v. theory is given, up to and including the fourth order. The coupling constants will also be different for charged and neutral pions, but the two effects may tend to cancel each other partially. G. FIELD

530.145

60. A variation principle in deutron problem. T. KIKUTA. Letter in *Progr. theor. Phys.*, **11**, *No.* 4–5, 493–4 (*April–May*, 1954).

If the binding energy and mixing ratio of S and D waves are given, it is possible to determine the depth of both central and tensor potential by a variational method. P. T. MATTHEWS

530.145

61. Renormalization in the covariant treatment of pion-nucleon scattering. S. CHIBA. Letter in *Progr. theor. Phys.*, **11**, *No.* 4–5, 494–6 (*April–May*, 1954).

A prescription is given for the renormalization of the second-order Bethe–Salpeter equation for meson-nucleon scattering, which, for an expansion in the coupling constant, is identical with the Dyson–Salam procedure. P. T. MATTHEWS

530.145

62. Covariant subtraction of "overlapping divergences" appearing in the pion-nucleon scattering. D. ITO AND H. TANAKA. Letter in *Progr. theor. Phys.*, **11**, *No.* 4–5, 501–3 (*April–May*, 1954).

Substantially the same as the preceding abstract. P. T. MATTHEWS

530.145

63. Composite states of two fermions through Fermi-type interaction. H. KATSUMORI. Letter in *Progr. theor. Phys.*, **11**, *No.* 4–5, 505–9 (*April–May*, 1954).

The suggestion that a boson is a bound state of two fermions [Abstr. 2686 (1950)] is examined on the basis of a Bethe–Salpeter equation with non-local interaction. P. T. MATTHEWS

530.145

64. The potential between nucleons. G. EDER. *Z. Naturforsch.*, **9a**, *No.* 7–8, 565–72 (*July–Aug.*, 1954) In German.

The potential resulting from second- and fourth-order meson theory is calculated from a single-time Bethe–Salpeter equation. Particular attention is paid to the nucleon recoil. With the potentials obtained, nuclear saturation is investigated. G. E. BROWN

530.145

65. Non-local field theory based on the Salpeter–Bethe equation. II. Exchange effect with localized particles. H. L. JORDAN AND W. E. FRAHN. *Z. Naturforsch.*, **9a**, *No.* 7–8, 572–8 (*July–Aug.*, 1954) In German.

Continuing previous work [Abstr. 3087 (1954)] the S.B. equation is treated for the interaction with localized heavy particles. In second-order perturbation the interaction is non-local. The simplest irreducible graphs of fourth order are calculated explicitly. The space-time structure of the interaction, and its transition to local potentials in the adiabatic limit, are discussed. P. T. MATTHEWS

530.145

66. On the polarization of high energy nucleons scattered by a nuclear field. B. BOSCO AND T. REGGE. Letter in *Nuovo Cimento*, **12**, *No.* 2, 285–7 (*Aug.*, 1954).

The polarization is worked out at $\theta = 0, 10, 20, 30, 50, 90^\circ$ for the same model as that of Fermi [Abstr. 5705 (1954)], but using an exact phase-shift analysis. The result shows large oscillations with θ. W. J. SWIATECKI

530.145

67. Two-nucleon problem when the potential is non-local but separable. II. YOS. YAMAGUCHI AND YOR. YAMAGUCHI. *Phys. Rev.*, **95**, *No.* 6, 1635–43 (*Sept.* 15, 1954).

For Pt I, see Abstr. 10805 (1954.) The two-nucleon problem is considered in terms of an interaction of the form $(\mathbf{p}|V|\mathbf{p}') = -(\lambda/M)g(\mathbf{p})g(\mathbf{p}')$, with $g(\mathbf{p}) = C(p) + (1/\sqrt{8})\{3p^{-2}(\boldsymbol{\sigma}^p.\mathbf{p})(\boldsymbol{\sigma}^n.\mathbf{p}) - (\boldsymbol{\sigma}^p.\boldsymbol{\sigma}^n)\}T(p)$, where the second term gives rise to a mixture of D-state with the S-state determined by the first term. After deriving general results valid for any form of $g(\mathbf{p})$, the special case of $C(p) = (p^2 + \beta^2)^{-1}$ and $T(p) = -tp^2(\gamma^2 + p^2)^{-2}$ is discussed in detail and compared with observed data. The photodisintegration of the deuteron is also discussed and it is found that the D-wave part of the deuteron plays an important role at high photon energies leading to a larger cross-section than given by other calculations to date. A.

530.145

68. Modified nucleon propagators. A. N. MITRA. Letter in *Phys. Rev.*, **95**, *No.* 6, 1697 (*Sept.* 15, 1954).

Feldman's considerations [Abstr. 4194 (1954)] are

extended to include some fourth-order self-energy graphs. It is found that for physically reasonable coupling constants, this modified propagator has a real pole at an energy less than the nucleon rest mass.
P. T. MATTHEWS

530.145

69. Nuclear saturation and two-body forces. II. Tensor forces. K. A. BRUECKNER. *Phys. Rev.*, **96,** *No.* 2, 508–16 (*Oct.* 15, 1954).

For Pt I, see Abstr. 8065 (1954). The method developed in Pt I for the treatment of the problem of nuclear saturation has been extended to the case of tensor forces. The general result obtained expresses the many-body potential energy as a function of the triplet and singlet eigen phase shifts for scattering. One consequence is that the tensor force, which averages to zero if Born approximation is used to evaluate the scattering, now gives a very sizeable contribution to the potential energy. Phase shifts have been determined for a specific potential model derived from pseudoscalar meson theory, and are shown to give scattering up to 90 MeV which is in good agreement with total cross-section and in approximate agreement with angular distributions. Use of these results to evaluate the total energy (neglecting Coulomb effects) in heavy nuclei shows that for a typical case ($A = 300$) saturation occurs at a radius $1{\cdot}15\times10^{-13}A^{\frac{1}{3}}$ with a binding energy of 10 MeV per particle. If surface effects are neglected, however, the density at saturation increases by a factor of 1·74 with an increase in mean binding energy to 39 MeV. The potential energy per particle has also been determined as a function of its momentum. In the finite nucleus ($A = 300$) the potential depth varies from −82 MeV for a particle of zero momentum to −32 MeV for a particle at the top of the Fermi momentum distribution. Arguments are presented which suggest that this effect is to a large extent independent of the model used. A.

530.145

70. Application of variational principles to scattering problems. H. E. MOSES. *Phys. Rev.*, **96,** *No.* 2, 519–22 (*Oct.* 15, 1954).

The Schwinger and Kohn–Hulthén variational principles are adapted to scattering problems in which only a part of the scattering potential is small. A.

530.145 : 539.165.2

Nuclear forces and β decay matrix elements. *See Abstr.* 490

530.145

71. On the formulation of quantum mechanics. II. Relativistic quantum mechanics. Dirac equation. B. MROWKA. *Z. Phys.*, **138,** *No.* 5, 557–69 (1954) In German.

The method of Pt I [Abstr. 775 (1952)] is used to derive relativistic wave equations of the Dirac type for a particle with spin and an arbitrary magnetic moment. G. J. KYNCH

530.145

72. Some remarks on relativistic wave functions with a mass spectrum. V. L. GINSBURG AND V. P. SILIN. Letter in *Zh. éksper. teor. Fiz.*, **27,** *No.* 1(7) 116–18 (1954) In Russian.

A critique of reasons given by previous authors for the inadmissibility of various equations. G. E. BROWN

530.145

73. A remark on quantum-mechanical perturbation theory. N. KEMMER. Note in *Proc. Cambridge Phil. Soc.*, **50,** *Pt* 4, 632–3 (*Oct.*, 1954).

A method is described for presenting time-independent perturbation theory, which has some advantages over the more usual presentations. It is not fundamentally new but may be an improvement in situations in which high-order perturbations are of interest. L. S. GODDARD

530.145

74. Justification, from the point of view of the theory of the double solution, of wave mechanics of systems in configuration space. L. DE BROGLIE. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 8, 565–8 (*Aug.* 23, 1954) In French.

The example of two interacting bodies is formulated non-relativistically in the centre of mass system and in the system centred on one of the particles. The relation between the two solutions is discussed.
G. E. BROWN

530.145.6

75. A foundation of quantum mechanics based on the statistics of particles. F. BOPP. *Z. Naturforsch.*, **9a,** *No.* 7–8, 579–600 (*July–Aug.*, 1954) In German.

The attempt is made to derive quantum mechanics from a purely statistical dynamics of particles, which is not derivable from Newtonian mechanics. The wave character of the statistical equations of motion follows necessarily from the peculiarity of quantum statistics according to which the symmetry with regard to time in the Schrödinger equation is connected with diffusion of wave packets. The possibility of probability waves (in the literal sense) presupposes the existence of particles. The motions of individual particles are not reproducible, but those of the statistical totality of particles are reproducible. The statistical equations of motion are linear and reversible.
F. ANSBACHER

530.162 : 536.7

76. Fundamental problem of statistical mechanics. I. Y. SUZUKI. *J. Coll. Arts Sci. Chiba Univ. Nat. Sci. Ser.*, **1,** *No.* 2, 109–12 (*March*, 1953).

It is shown that a variational principle can be set up for thermodynamics, and that the transformation theory of linear differential forms can be applied as in classical mechanics, with inverse temperature taking the place of time. The existence of an implicit relation between time and temperature is confirmed by an examination of Yamasaki's attempt [*Proc. Phys.-Math. Soc. Japan*, **24,** 821 (1942). See also Abstr. 5249 (1949)] to overcome the divergence difficulty in field theory by introducing complex space and time coordinates. An attempt is made to formulate a unified quantum statistical mechanics on the basis of a complex temperature formalism. A distinction is made between "orthogonal" and "exponential" resolution of the state function, the former making it

possible to include non-stationary states in the formalism. E. H. SONDHEIMER

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.36

77. The theory of the vibrations of a balance which is attached to a vertical torsion-wire according to Eötvös–Selényi. G. GYÖRGYI. *Acta phys. Hungar.*, **4**, *No.* 1, 79–86 (1954) In German.

Modifications of Eötvös' torsion-balance, which measures the Coriolis force due to the Earth's rotation, have recently been put forward by Selényi [Abstr. 7572 (1951)]. These are analysed and a mathematical theory is proposed for the explanation of an observable disturbing instrumental effect. The conditions are evaluated under which these disturbances are negligible as compared with the measured quantities, which leads to their compensation through an appropriate adjustment of the instrument. A. BEER

MECHANICAL MEASUREMENTS 531.7

531.711 : 535.41

Optical interference with a metre path difference. *See Abstr.* 222

531.764.5 : 621.317.79

78. Simple clock with a quartz tuning fork. L. D. BRŸZZHEV AND V. N. TITOV. *Zh. tekh. Fiz.*, **24**, *No.* 5, 879–83 (1954) In Russian.

The clock consists of a quartz tuning fork placed in a thermostat, a synchronous motor operating at 24 V and the associated electrical circuit. The tuning fork has dimensions of $111{\cdot}3\times20{\cdot}6\times10$ mm and oscillates at 1000 c/s. The motor operates at one rev/sec, when driven by current impulses recurring at 100 c/s, its power consumption being 0·001 VA. The daily error of the clock is $\pm0{\cdot}002$ sec, corresponding to a relative change in frequency of $\pm2\times10^{-8}$. A detailed diagram of the electrical circuit is given. R. S. SIDOROWICZ

MECHANICS OF FLUIDS 532

532.13 : 533.16

79. A relation between the activation energy for viscous flow and the Lennard–Jones (12, 6) potential parameter, ϵ/k. C. J. G. RAW. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1627 (*Sept.*, 1954).

Using the Ewell-Eyring semi-empirical relation for normal liquids, $\Delta E_{visc} = \Delta E_{vap}/3$, and the Lennard–Jones–Devonshire expression for ΔE_{vap} in terms of the depth of the intermolecular potential (ε) on a (12, 6) force law, it follows that $E_{visc} \equiv Rd \ln \eta/d \ln (1/T) = 4{\cdot}5\varepsilon/k$ cal mole^{-1}. This is tested against the data for A, N_2, O_2, CO, CH_4 and found to give reasonable agreement, except for O_2. A connection between the viscosity of the gas and the liquid is thereby disclosed, since ε can be found from the gas viscosity alone. R. O. DAVIES

532.13 : 534.23

80. A discussion on the first and second viscosities of fluids. *Proc. Roy. Soc. A*, **226**, 1–69 (*Oct.* 21, 1954).

The discussion was held in April, 1954. See abstracts following.

532.13 : 534.23

81. A discussion on the first and second viscosities of fluids: The second coefficient of viscosity: a brief review of fundamentals. L. ROSENHEAD. *Proc. Roy. Soc. A*, **226**, 1–6 (*Oct.* 21, 1954).

The generally assumed relationship between the principal stresses and the principal rates of deformation, at any point of any homogeneous fluid, introduces, as empirical constants, the first (μ, shear) and second (μ', dilatational) coefficients of viscosity. The assumption receives justification only if it can be verified experimentally or if it leads to theoretical conclusions which can be shown to agree with the results of experiments. The relevant experimental evidence seems to come from the phenomena of the absorption of sound energy in so-called "liquids," and from those of acoustical streaming. One important conclusion is that there should be no general correlation between the values of μ and μ'; the theoretical conclusion that μ'/μ should be equal to $-\frac{2}{3}$ has some validity only when referring to ideal monatomic gases. The ideas put forward by Tisza (1942), Eckart (1948), and the experiments of Liebermann (1949) seem to have made a notable advance, but a completely satisfactory explanation of the phenomena is still lacking. A.

532.13 : 534.23

82. A discussion on the first and second viscosities of fluids: Kinetic and thermodynamic aspects of the second coefficient of viscosity. R. O. DAVIES. *Proc. Roy. Soc. A*, **226**, 24–34 (*Oct.* 21, 1954).

There are two macroscopic theories of bulk viscosity in fluids. The first is contained in the classical theory of hydrodynamics in which the instantaneous state of an element in the fluid is determined by two thermodynamic variables. This theory fails to account for sound absorption in a number of fluids (such as carbon disulphide). To do this, more than two thermodynamic variables must be introduced into a relaxation theory. This can be combined with hydrodynamics. In the acoustic approximation a wave equation can be formed and the resulting propagation of plane waves can be investigated. Under certain restrictions it is shown that (*a*) the presence of relaxation involves a correction to the "classically" determined part of the absorption coefficient, (*b*) at frequencies much lower than the inverse relaxation time there is no way of distinguishing contributions to absorption due to bulk viscosity ($\mu' + \frac{4}{3}\mu$) and those due to relaxation. In a review of the kinetic calculations of bulk viscosity it is pointed out that the approximation used in Kirkwood's work automatically excludes relaxation behaviour. A.

532.13 : 534.23

83. A discussion on the first and second viscosities of fluids: The two coefficients of viscosity for an incompressible fluid containing air bubbles. G. TAYLOR. *Proc. Roy. Soc. A*, **226**, 34–7 (*Oct.* 21, 1954).

Incompressible fluids possess only one coefficient of viscosity because, by definition, no changes in volume can occur. If such a fluid contains air bubbles it becomes compressible, and any changes in volume involve a contraction or expansion of the bubbles which is resisted by the ordinary viscosity of the surrounding fluid. The resulting second coefficient of viscosity is found to be $4\mu/3v$, where μ is the viscosity of the incompressible fluid and v the (small) proportion of the total volume which is occupied by the bubbles.

The effect of compressibility in the fluid is discussed in Notes by Taylor and Davies (abstracts following). In the second of these it is shown that a relaxation time must exist and in the first the volume viscosity of water containing air bubbles is calculated. This is found to reach a maximum value of 6700 times the viscosity of water when $v = 5 \times 10^{-5}$. A.

532.13 : 534.23

84. A discussion on the first and second viscosities of fluids: Note on the volume viscosity of water containing bubbles. G. TAYLOR. *Proc. Roy. Soc. A*, **226**, 38–9 (*Oct.* 21, 1954). See preceding abstract.

532.13 : 534.23

85. A discussion on the first and second viscosities of fluids: A note on Sir Geoffrey Taylor's paper. R. O. DAVIES. *Proc. Roy. Soc. A*, **226**, 39 (*Oct.* 21, 1954).

See two preceding abstracts.

532.13 : 534.23

86. A discussion on the first and second viscosities of fluids: Transport and relaxation phenomena. H. O. KNESER. *Proc. Roy. Soc. A*, **226**, 40–2 (*Oct.* 21, 1954).

Relaxation phenomena occur whenever a heat flow, mass flow or momentum flow is not permitted enough time to reach a stationary state. Therefore all transport phenomena can be associated with relaxation processes. The momentum flow (viscosity) can, in fact, be associated with two essentially different processes; this is due to the vector character of the transported quantity. A.

532.13 : 534.23

87. A discussion on the first and second viscosities of fluids: On the thermodynamic theory of the second viscosity. J. MEIXNER. *Proc. Roy. Soc. A*, **226**, 51–6 (*Oct.* 21, 1954).

It seems possible to reconcile the Navier–Stokes equations and the thermodynamic theory of relaxation, but a full insight into the problem of the two viscosities may be obtained by considering the liquid as a limiting case of an elastic body with "after-effects." The after-effect theory, when applied to a generalized stress-strain relation that contains temperature and entropy besides the components of the strain and stress tensors, leads to interesting results; for instance, it can be proved that the compression and shear moduli, divided by p, are positive functions in p ($=i\omega$, where ω is the frequency), in the sense of the electric network terminology. In such materials one can define an apparent viscosity matrix; its essential components in the special case of isotropic viscoelastic substances are the first and the second viscosities, which are positive functions too. It is not possible to represent an arbitrary after-effect behaviour of a material by a thermodynamic theory of relaxation in the usual sense, except if the relaxation times are real and positive and some other conditions are fulfilled, but it seems that an appropriate extension of the thermodynamic theory can be made. In those cases that are suitable for a thermodynamic treatment, the internal variables representing the internal mechanisms divide, for isotropic substances, into two groups; the one containing invariant variables, active only in compression, the other containing sets of five variables with tensor character, and active only in shear deformation. It is essential for a thermodynamic treatment of shear relaxation to represent each molecular mechanism by such a set of five internal variables. A.

532.13 : 534.23

88. A discussion on the first and second viscosities of fluids: Experimental determination of the second viscosity. S. M. KARIM. *Proc. Roy. Soc. A*, **226**, 56–7 (*Oct.* 21, 1954).

532.13 : 534.23

89. A discussion on the first and second viscosities of fluids: Note on the hydrodynamic and thermodynamic pressures. J. G. OLDROYD. *Proc. Roy. Soc. A*, **226**, 57–8 (*Oct.* 21, 1954).

532.13 : 534.23

90. A discussion on the first and second viscosities of fluids: The present status of the controversy regarding the bulk viscosity of fluids. C. TRUESDELL. *Proc. Roy. Soc. A*, **226**, 59–65 (*Oct.* 21, 1954).

532.13 : 534.23

91. A discussion on the first and second viscosities of fluids: Vorticity generated by sound. P. E. DOAK. *Proc. Roy. Soc. A*, **226**, 7–16 (*Oct.* 21, 1954).

A revision is given of the basic theory of second-order effects caused by acoustic disturbances in a fluid, especially the vorticity giving rise to the ultrasonic wind, which was first explained by Eckart. The ultrasonic wind is produced by the interaction of the radiative and the non-radiative components of the acoustic motion. The wind speed is for the most part proportional to the acoustic attenuation coefficient. Wind-speed measurements thus usually furnish no more information about the second coefficient of viscosity, or the bulk viscosity, than do other attenuation measurements. It appears reasonable to regard the Stokesian bulk viscosity coefficient as a parameter of intramolecular and intermolecular relaxation processes. It does not have a unique value for all frequencies. Provided other parameters such as the coefficients of shear viscosity and heat conduction, and the specific heats are known independently, this effective bulk viscosity can be evaluated from any type of attenuation measurement. Measurements over large enough frequency ranges can distinguish among the contributions of different relaxation processes to the effective bulk viscosity coefficient. A.

532.13 : 534.23

92. A discussion on the first and second viscosities of fluids: Acoustic experiments relating to the coefficients of viscosity of various liquids. E. G. RICHARDSON. *Proc. Roy. Soc. A*, **226**, 16–24 (*Oct.* 21, 1954).

The concept of second viscosity was revived to explain the high attenuation, much greater than their first viscosity would justify, of ultrasonics in certain organic liquids. Certainly these liquids are more sensitive to second-order effects such as the production of streaming from a sound source immersed therein, which—under certain circumstances—may be related to the observed ultrasonic absorption. On the other hand, the heat generated during the passage of the ultrasonics is of the same order as that produced in a liquid of the same first viscosity. Experiments in which compressional waves are propagated through the liquid contained in a capillary tube show that the first viscosity is adequate to predict the attenuation, and the same coefficient explains the propagation of shear waves into the liquid. A.

532.13 : 534.23

93. A discussion on the first and second viscosities of fluids: Acoustic streaming in liquids. J. E. PIERCY AND J. LAMB. *Proc. Roy. Soc. A*, **226**, 43–50 (*Oct.* 21, 1954).

It has been suggested by Eckart (1948), Liebermann (1949) and others that measurement of acoustic streaming in a fluid provides an independent means of evaluating the ratio of the second coefficient of viscosity to the coefficient of shear viscosity. Arguments are put forward here to support the view (Nyborg, 1953) that the streaming velocity is directly dependent on the coefficient of sound absorption. The second coefficient of viscosity influences the velocity of streaming only through its relationship to the coefficient of sound absorption. It is concluded that measurements of streaming velocity do not yield information about the second coefficient of viscosity other than may be obtained from the direct measurement of sound absorption. The theory of streaming based on the gradient of radiation pressure has been established quantitatively by a solution of the Navier–Stokes equations. A description is given of a method of determining the sound-absorption coefficient of a liquid from measurements of the velocity of streaming, and some typical results are stated. A.

532.13 : 534.23

94. A discussion on the first and second viscosities of fluids: Ultrasonic measurements and the second viscosity of carbon disulphide. J. H. ANDREAE AND J. LAMB. *Proc. Roy. Soc. A*, **226**, 51 (*Oct.* 21, 1954).

532.13 : 534.23

95. A discussion on the first and second viscosities of fluids: Review of discussion. E. N. DA C. ANDRADE. *Proc. Roy. Soc. A*, **226**, 65–9 (*Oct.* 21, 1954).

532.13 : 536.432.15

96. Vapor pressure and viscosity of liquids. S. S. MITRA AND D. N. CHAKRAVARTY. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1775–6 (*Oct.* 1954).

An empirical relation [see Abstr. 5326 (1954)] is amended for water and ethyl alcohol to read $\log p + aT^b \log \eta + c\,(\log \eta)^2 = d$, with a, b, c and d constants. R. O. DAVIES

532.13 : 591.111.4

Apparatus for measuring relative blood viscosity. *See Abstr.* 662

532.23

97. Taylor instability of the interface between superposed fluids—solution by successive approximations. R. L. INGRAHAM. *Proc. Phys. Soc.* [*London*] *B*, **67**, *Pt* 10, 748–52 (*Oct.*, 1954).

A solution of the hydrodynamical equations for the case of Taylor instability for two fluids of constant density is sought by the method of successive approximations. The expansion parameter is the initial amplitude of the interface; the validity of the method then assumes convergence of the series involved. The linear equations to be solved at the pth step for the pth order unknown fields are derived. The solution is actually carried out up to the second approximation. An interesting feature of this solution is that its time growth comports not only the integral modes $\exp(\sigma t)$ and $\exp(2\sigma t)$, but also the irrational mode $\exp(\sqrt{2}\sigma t)$, in terms of the growth parameter $\sigma \equiv \{gk(\rho' - \rho)/(\rho' + \rho)\}^{1/2}$. A.

532.517.2

98. Flow of melts in "crosshead"-slit dies; criteria for die design. J. F. CARLEY. *J. appl. Phys.*, **25**, *No.* 9, 1118–23 (*Sept.*, 1954).

"Crosshead"-slit dies are widely used for the extrusion of polymer sheeting, flat film and blown film. In this paper the laminar flow of liquids in such dies is analysed, and an equation derived relating pressure to position along the slit for materials that obey the "power law." The equation yields an index of uniformity (*UI*), which is the ratio of the rate of extrusion at the far end to that at the feed end. An illustrated procedure is given for designing dies that will make film whose caliper is satisfactorily uniform over its whole width. The *UI* for centre-fed dies is always greater than for end-fed dies of the same length. A.

532.517.2 : 538.69

99. Laminar flow of an electrically conducting incompressible fluid in a circular pipe. S. I. PAI. Letter in *J. appl. Phys.*, **25**, *No.* 9, 1205–7 (*Sept.*, 1954).

The problem is difficult since it is necessary to solve the electromagnetic and hydrodynamic equations simultaneously, and since it is well known that no general method exists for the latter it is necessary to find some simple exact solutions of magnetohydrodynamical equations in order to establish the essentials of magneto-hydrodynamics. The problem stated in the title is therefore solved exactly for an external radial magnetic field. It is established that in many respects magnetohydrodynamical flow is similar to turbulent flow. T. C. TOYE

532.517.4

100. The symmetry character of the turbulence tensor. H. ERTEL. *S.B. Dtsch. Akad. Wiss. Berlin, Kl. Math. Nat.*, **1953**, *No.* 2, 9 *pp.* In German.

Some phenomenological theorems about the turbulence-current theory are stated, and it is shown that these determine uniquely the symmetry of the turbulence tensor. L. S. GODDARD

532.527 : 778.37

101. Vortex rings of water in air. H. ROHATSCHEK AND E. DESOYER. Note in *Naturwissenschaften*, **41**, *No.* 15, 355 (1954) In German.

The break-up of a water jet into vortex rings with increasing velocity is clearly demonstrated by high-speed action photographs. T. C. TOYE

532.528 : 534.39

102. Ultrasonic cavitation thresholds in water. W. CONNOLLY AND F. E. FOX. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 843–8 (*Sept.*, 1954).

The temperature dependence of the minimum sound pressure needed to produce cavitation in gassy water has been measured over a range of 0 to 30°C. Both plane progressive and focused waves of frequency one megacycle per second were used. The cavitation pressure threshold P_c is not a linear function of temperature, and increases by a factor of 2·5 between 30 and 0°C. About 50% higher sound-pressure amplitude is needed to initiate cavitation than to maintain it. The relation of P_c to the reciprocal temperature, to viscosity, and to the degree of undersaturation is discussed. A.

532.528 : 534.39

103. An experimental study of acoustically induced cavitation in liquids. W. J. GALLOWAY. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 849–59 (*Sept.*, 1954).

An apparatus has been assembled for the study of sonically induced cavitation in the frequency range of 20 to 40 kc/s. Radially symmetric standing waves are produced in a spherical resonator driven externally by a magnetostriction transducer. The acoustic pressure within the sphere is measured by a small barium-titanate transducer positioned at secondary maxima of the standing pressure wave. Equipment is provided for measuring the gas content of the liquid being studied. Measurements of cavitation thresholds as functions of air content, hydrostatic pressure, temperature and surface tension have been made using different liquids. The highest thresholds measured were 200 bars for water and 140 bars for benzine (petroleum ether). The air content of the liquid appears to be the dominant factor limiting the maximal negative pressure which the liquid can withstand as long as the air content is greater than 5% of saturation. At lower percentages of air saturation the threshold becomes essentially independent of air content, becoming limited by as yet undetermined factors. A.

532.57

104. Review of some methods of flow measurement. W. A. WILDHACK. *Science*, **120**, 191–7 (*Aug.* 6, 1954).

CAPILLARITY 532.6

532.623 : 551.574.1

105. Bursting of air bubbles at the surface of sea water. B. J. MASON. Letter in *Nature* [*London*] **174**, 470–1 (*Sept.* 4, 1954).

Bubbles between 0·3 and 4·3 mm diameter at the surface of sea water have been studied. As well as large droplets projected vertically on bursting all diameter bubbles appear to produce a number of very small bubbles projected horizontally. Cloud chamber experiments on fresh water and sea water show that bubbles bursting at the surface of the latter produce a cloud of small droplets, thought to be due to production of very small salt particles which act as condensation nuclei. [See also Abstr. 2954, 5335 and 8954 (1954).] T. C. TOYE

532.64

106. Angle of contact of mercury against a moving tungsten wire. A. H. COOK AND N. W. B. STONE. Letter in *Nature* [*London*] **174**, 366–7 (*Aug.* 21, 1954).

The contact angle between mercury and a thin tungsten wire suspending a tungsten carbide cube in the mercury, from one arm of a balance oscillating with a period of 32 sec was measured and found to vary periodically, suggesting the existence of a non-linear functional contact force. T. C. TOYE

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

107. Neutron diffraction study of liquid mercury. G. H. VINEYARD. *J. chem. Phys.*, **22**, *No.* 10, 1665–7 (*Oct.*, 1954).

The neutron diffraction pattern of liquid mercury at 23° c has been measured. The pattern has general resemblance to the X-ray patterns obtained by Debye and Menke and by Jennings, although the angular resolution is not quite as good. The inner peak which has been reported by several investigators is not seen. The radial density function has been calculated from the data. A.

532.7 : 532.13

108. Approximate treatment of the viscosity of idealized liquids. I. The collisional contribution. F. C. COLLINS AND H. RAFFEL. *J. chem. Phys.*, **22**, *No.* 10, 1728–33 (*Oct.*, 1954).

The instantaneous transport of momentum across the bodies of molecules occurs upon molecular collision in a rigid sphere liquid undergoing viscous flow. The contribution of this effect to the viscosity is calculated on a quasi-equilibrium basis for a liquid consisting of hard spherical molecules. The calculation makes use of the free volume theory, a correction being introduced to take account of the blocking effect of third neighbours. The equation so obtained may be expressed in terms of the adiabatic compressibility of the liquid and its heat of vaporization. The calculated viscosity contributions are of the order of a quarter to a half of the experimental viscosities for various low molecular weight liquids investigated. The temperature coefficients of the viscosity contributions are also lower than those of the experimental viscosities. A.

532.7 : 539.11

Electronic structure of disordered one-dimensional chains. *See Abstr.* 410

532.72

109. Contribution to the theory of thermal diffusion in liquids. I. On the connection between the kinetic and phenomenological theories of transport processes in continuous systems. K. F. ALEXANDER. *Z. phys. Chem.* [*Leipzig*] **203,** *No.* 3–4, 181–202 (*Aug.*, 1954) In German.

Contradictions between the usual kinetic models and the general phenomenological theory of the diffusion process in liquids are brought out, e.g. by the fact that the coefficients of the phenomenological equations of motion cannot be simply connected with the molecular mobilities. The contradiction can, however, be eliminated by a simple transformation of the equations, leading to a diagonalization of the coefficient-matrix. The proposed transformation is equivalent to the introduction of a moving reference frame into the kinetic theory. This is physically interpreted as the translation of a quasi-crystalline "lattice" in the liquid, which, however, cannot be directly macroscopically observed. T. P. BRODY

532.72

110. Contribution to the theory of thermal diffusion in liquids. II. Diffusion and thermal diffusion in liquid binary mixtures and solutions. K. F. ALEXANDER. *Z. phys. Chem.* [*Leipzig*] **203,** *No.* 3–4, 203–12 (*Aug.*, 1954) In German.

The relations deduced in Pt I are applied to the case of mixtures of two neutral components and to binary electrolytes. The diffusion coefficients, Soret coefficients and thermal diffusion potentials are derived. It is found that even in infinitely dilute solutions the kinetic heat of transport of the solvent enters into the expression for the Soret coefficient. Thus a kinetic discussion of thermal diffusion is incomplete without an explicit consideration of the kinetic properties of the solvent. T. P. BRODY

532.72

111. Contribution to the theory of thermal diffusion in liquids. III. Determination of Soret coefficients of dilute aqueous alkali halogenide solutions at mean temperatures of 30, 40, 50 and 60° C. K. F. ALEXANDER. *Z. phys. Chem.* [*Leipzig*] **203,** *No.* 3–4, 213–27 (*Aug.*, 1954) In German.

The measurements were carried out using a Clusius separation tube at a mean temperature difference of 17°C. A strong dependence of the coefficients on the temperature was found, and their additive property in terms of ionic components was confirmed within experimental error. T. P. BRODY

532.72

112. Contribution to the theory of thermal diffusion in liquids. IV. Heat of transport and structure of aqueous electrolytes. K. F. ALEXANDER. *Z. phys. Chem.* [*Leipzig*] **203,** *No.* 3–4, 228–46 (*Aug.*, 1954) In German.

The influence of concentration and temperature changes on the heat of transport is analysed. It is concluded that a change in the state of association of the water strongly affects its heat of transport. From the relation between concentration and heat of transport one can estimate the effect of the respective ions on the changes of structure. To interpret the temperature dependence of the heats of transport in dilute solutions one must, in addition to this "solvent influence," also consider the "ion influence". This latter can be brought into relation with the temperature dependence of ion hydration. T. P. BRODY

532.72

113. The measurement of translational diffusion coefficients. I–II. T. J. BOWEN. *Lab. Pract.*, **3,** *No.* 9, 369–73 (*Sept.*); *No.* 10, 414–17 (*Oct.*, 1954).

A review. The coefficient, D, is of importance in the study of macromolecules. In Pt I, seven methods of calculation of D, assuming the validity of Fick's law, are briefly described and the uses to which these D values are put are stated. In Pt II the experimental determination of D is discussed. Various types of cell suitable for the free boundary diffusion method are illustrated and the porous disk and surface tension methods are briefly described. 38 and 36 refs. respectively. S. WEINTROUB

532.74 : 530.162

114. *N*-particle distribution functions. H. L. FRISCH. *J. chem. Phys.*, **22,** *No.* 10, 1713–17 (*Oct.*, 1954).

An investigation of a certain class of approximate solutions of the Yvon-Born-Green recurrence relations for the lower-dimensional molecular distribution functions has been presented, based on a particular mechanism of exclusion of interactions among "clusters" composed of successively larger numbers of molecules. This mechanism leads to a chain of equations for the approximate distribution functions which (*a*) converge to the exact molecular distribution function after a finite number of approximations, (*b*) are linear in the dependent variable just like the Yvon-Born-Green recurrence relations, and (*c*) are time reversible. The connection between these equations and certain natural generalizations of Boltzmann's equation to other than binary collisions is obtained. Finally the application of this hierarchy to certain problems of fluids at equilibrium has been indicated. A.

532.78

115. Solute redistribution by recrystallization. R. G. POHL. *J. appl. Phys.*, **25,** *No.* 9, 1170–8 (*Sept.*, 1954).

The time-dependent diffusion equation is solved using transformation calculus to obtain the solute concentration in a solvent after a segregating liquid-solid interface is passed through the material. The results are presented in graphical and tabular form for typical experimental conditions and compared with previously published findings. A.

MECHANICS OF GASES 533

533.15 : 536.23

116. The approach to the steady state in gaseous thermal diffusion and its application to determining the dependence of gas diffusivity on the concentration ratio. P. T. NETTLEY. *Proc. Phys. Soc.* [*London*] *B*, **67,** *Pt* 10, 753–60 (*Oct.*, 1954).

The approach to the steady state in gaseous thermal diffusion has been studied using a conventional

apparatus consisting of two vessels joined by a connecting tube. The investigation was confined to mixtures of hydrogen and nitrogen. The rate of approach to the steady state was found to be exponential with mixtures of these two gases. It was also found that the rate of approach to the steady state decreased slightly as the percentage of the lighter gas increased. Since the theory shows that the rate of approach to equilibrium is proportional to the coefficient of diffusion D_{12}, this suggests that the coefficient D_{12} decreases as the percentage of light gas increases. The experimental variation of the coefficient D_{12} with concentration as determined in this way is compared with that predicted for the rigid elastic sphere type of molecule. The advantages of this method of measuring changes of the coefficient of diffusion with concentration ratio over the ordinary diffusion method are discussed. A.

533.16 : 532.13

A relation between the activation energy for viscous flow and the Lennard-Jones (12, 6) potential parameter, ϵ/k. *See Abstr.* 79

533.5 : 531.788.7

117. Ultimate vacuum in a vacuum-enclosed ionization gauge. L. J. Varnerin, Jr and D. White. Letter in *J. appl. Phys.*, **25**, *No.* 9, 1207–8 (*Sept.*, 1954).

In an ultra-high vacuum system, the lowest pressures, obtained by continued pumping with a Bayard–Alpert ionization gauge after isolation of the system from the pump, were limited by the rate of diffusion of atmospheric He through the glass. By enclosing the ionization gauge in a vacuum, the total residual pressure was reduced to substantially less than 10^{-11} mm equivalent nitrogen pressure. At these pressures, the very low ionization currents are augmented by an X-ray current which interferes with their measurement. By lowering the grid voltages for the measurement of the ion-current from 150 V to 70 V, a larger ratio of ion-current to X-ray current is obtained. G. WITTENBERG

MOLECULAR THEORY OF GASES 533.7

533.7

118. Distribution functions and isotropic gases. G. C. Benson and E. A. Flood. *Amer. J. Phys.*, **22**, *No.* 8, 550–2 (*Nov.*, 1954).

The concept of the isotropy of a perfect gas is examined from the point of view of the distribution functions for molecular speed and velocity components. It is shown that to be compatible with the assumption of isotropy, any velocity component distribution function must satisfy several general relations. These relations are often presented as a consequence of the Maxwellian distribution but are shown to be independent of the form of the distribution of molecular speeds. A.

533.7 : 536.423.4

On the theory of condensing systems. *See Abstr.* 246

533.7 : 536.7

119. A proposal for fundamental equations of dynamics of gases under high stress (a proposal for statistical mechanical treatment of systems not in thermal equilibrium associated with transport phenomena). T. Koga. *J. chem. Phys.*, **22**, *No.* 10, 1633–46 (*Oct.*, 1954).

In order to derive the fundamental equations of gas dynamics which are valid for the flow at high shearing stress and low gas pressure, an attempt was made to eliminate the assumption that the state concerned departs only slightly from thermal equilibrium, as phenomena are frequently found which cannot be treated under this assumption. First, the state of gas in an intermediate volume element was microscopically represented in terms of the quantities of transport. Considering their averages over an intermediate time interval, an attempt was made to find the statistical character of the system. In other words, under the assumption that the macroscopic observation is possible or that the macroscopic law can be established, it was shown that the Boltzmann–Planck method in a new sense is applicable to the present systems. The new distribution function thus derived, $f = \exp(\alpha + \Sigma\beta_\xi c_\xi + \Sigma\Sigma\gamma_{\xi\eta} c_\xi c_\eta + \ldots)$ (where c denotes the velocity of a particle), should satisfy the Boltzmann–Maxwell equation. This can be shown by means of Kirkwood's verification accepted in some extended meaning. In solving the Boltzmann–Maxwell Equation from this new standpoint, the stress components were taken together with mass density and velocity of mass motion as the independent variables in the zeroth approximation, although usually temperature is taken in place of stress. This method of treatment is analogous to that of Enskog and Chapman, although some important modifications are found in the latter half of the treatment. The fundamental equations of gas dynamics have been derived. Instead of viscosity and thermal conductivity, a new conception arises in the equations. That conception is conductivity of stress. A.

VIBRATIONS . ACOUSTICS 534

534.121

120. Radial vibrations of thick-walled hollow cylinders. J. A. McFadden. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 714–15 (*Sept.*, 1954).

Approximate formulae are given for the natural wavelengths associated with the free radial vibration of a thick-walled, infinitely long, hollow cylinder. For the radial extensional mode, the wavelength is nearly proportional to the nth-order mean radius, where n depends on Poisson's ratio. For the thickness modes, a correction factor is derived which may be applied to the plane-wave solution. The extensional solution is also applied to the case of a thin, flat washer. A.

534.121.2

121. Theory of the effect of a thin air film on the vibrations of a stretched circular membrane. D. H. Robey. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 740–5 (*Sept.*, 1954).

In the design of condenser microphones it is standard practice to insert holes or furrows into the electrode face. This modification helps to prevent

radial air flow through the electrode-membrane interstice which can result in large dissipative and reactive effects, provided the separation is small. The theory governing air reactions from an unmodified electrode is presented. An attempt was made to start with general fundamental equations. Only those simplifications which appeared to have a negligible effect on the accuracy of the results were made; for example, body forces and nonlinear terms have been neglected. Air inertia, rotational and irrotational velocity components, and viscous terms have been retained in the theory. Curves showing the effects of air reactions on the amplitude, phase, and impedance of a stretched titanium membrane are shown. The air stiffness, which continuously increased for increasing frequencies in the range 5 to 20 000 c/s, caused the amplitude of the membrane to diminish by more than 20 db. In general, air which is trapped behind the membrane will cause the response of the microphone to rise as the frequency is lowered. A.

534.142.4

122. Burner oscillations of the gauze-tone type. A. A. Putnam and W. R. Dennis. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 716–25 (*Sept.*, 1954).

Acoustic oscillations produced when a flame burns from a grid in an 8 in. diameter chamber were studied. The similarity between these oscillations and the Rijke gauze tones is pointed out. A theory is proposed for the gauze tones which is based on a phase lag between changes in flow rate and changes in heat-transfer rate. The predictions of the theory are shown to agree with test results. Indirect confirmation of the theory is given, but more work remains to be done before the theory can be completely proved or disproved. A.

534.21/.24

123. Propagation of sound over single absorptive strips in ducts. J. E. Young. *J. Acoust. Soc. Amer.*, **25**, *No.* 5, 804–18 (*Sept.*, 1954).

The behaviour of single absorptive strips imbedded in one wall of a hard duct is discussed by several approximate methods. The approximations are introduced in the order of increasing complexity. As a result an orderly scheme is obtained by means of which one can predict relevant physical quantities, such as attenuation, reflection coefficient, etc., with an accuracy suitable for practical utilization. It is assumed throughout that the strips, extending over the width of one wall but of specified length, can be described by their normal impedance ratios. The excitation of the strip-duct structure is that due to a plane wave. Measurements taken for a range of strip-wavelength ratios such that $0{\cdot}56 \leqslant kl \leqslant 22{\cdot}4$ indicate that the lumped-parameter approximation is generally inadequate. A variational principle is derived which together with suitable trial functions yields attenuations agreeing with measurements to within a few percent over the entire range of kl values. Some attention is given to those limiting strip configurations for which other authors have obtained exact solutions. Comparisons are made between these and the present results. A.

534.21 : 535.12 : 538.566

124. Criterion of the applicability of geometrical optics to problems of the propagation of waves through a medium characterized by slight refractive index variations. V. I. Tatarskiĭ. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1 (7) 84–6 (1953) In Russian.

Ellison's method [Abstr. 1553 (1952)] is used for obtaining a more general criterion ensuring the coincidence of wave-functions resulting from the solutions of the two fundamental equations involved. It is shown that conditions $\lambda \ll l$, and $\lambda L \ll l^2$ (where λ is the length of the propagated wave, l is the mean size of inhomogeneities, and L is the path of wave in the inhomogeneous medium) are sufficient for ensuring the coincidence of both the amplitudes and phases in the geometrical and wave solutions.

F. LACHMAN

534.213 : 532.517.4

125. Theory of the propagation of sound waves in a turbulent stream. V. I. Tatarskiĭ. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1 (7) 74–80 (1953) In Russian.

Examines in detail the problem of the scattering of sound waves for the case of isotropic turbulence in an incompressible liquid. Investigates the general form of the scattering indicatrix and develops for it an expression based on the formula $R_{rr}(\rho) = \bar{u}^2 \exp(-\rho l)/3$, where $\bar{u}^2$ is the mean square value of the pulsation velocity of the stream, $\rho =$ one of the spherical coordinates of the point, and $l =$ the correlation scale characteristic of the average pulsation size. The analysis of this phenomenon, based on the scattering theory, yields the mean square fluctuations of the phase and amplitude of sound at large distances from the source. F. LACHMAN

534.213

126. The propagation of elastic waves in thin-walled cylindrical shells. M. C. Junger and F. J. Rosato. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 709–13 (*Sept.*, 1954).

A study of the propagation in the walls. Two modes of propagation in the axial direction are found to exist; at high frequencies, the one corresponds to flexural waves, the other to longitudinal waves. The dispersion curves are in good agreement with published experimental data. Hitherto available analyses are based on the membrane theory of shells, which disregards bending stresses; these analyses lead to partly different conclusions in that they predict a "dead" frequency region where no propagation occurs, and in that they do not account for the high-frequency flexural mode. The discrepancy carries over into the evaluation of the natural frequencies of the tube, and of the dispersion of pressure waves propagating in liquid-filled tubes. Published experimental data on the latter process at ultrasonic frequencies also support the present analysis. Results of this analysis have been applied to the investigation of the dynamics of barium titanate transducers in the form of cylindrical shells. Some important concepts of sound insulation by lightweight partitions such as the "coincidence dip," depend essentially on the ratio of the sound velocity in air to the phase velocity of elastic waves in the partition; the present analysis might therefore also find a practical application in the adaptation of these concepts to cylindrical surfaces, such as the skin of aircraft fuselages or architectural shells. A.

534.213.4

127. On acoustic boundary layer heating. O. K. Mawardi. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 726–31 (*Sept.*, 1954).

The conventional investigations of the propagation of sound waves in conduits, when taking into account the effect of dissipation through friction and conduction of heat through the walls, assume the fluctuating part of the temperature of the gas to vanish at the boundaries. This is in essence a first-order approximation. Very different effects, however, are expected when second-order terms are considered. The purpose of the present paper is to discuss in detail the nature of the solution obtained from a second-order approximation. A.

534.22/.23

128. Relaxation processes in aqueous solutions of $MnSO_4$ and $CoSO_4$. E. L. Carstensen. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 862–4 (*Sept.*, 1954).

Absorption and velocity dispersion in the electrolytes $MnSO_4$ and $CoSO_4$ have been measured using difference techniques. Good agreement is found between measured velocity dispersion and that which is predicted by simple relaxation theory from the measured values of absorption. A.

534.22

129. Velocity of propagation of ultrasonic waves in solids. N. F. Otpushchennikov. Letter in *Zh. éksper. teor. Fiz.*, **25**, *No.* 1 (7) 127–8 (1953) In Russian.

See also Abstr. 8743 (1952), 1448 (1953). Tabulates results of further measurements (for 8 solids: white marble, iron, white porcelain, cast iron, flint glass, polystyrene, rosin, and oak wood across the grain), the frequency being 3·55 Mc/s. The theoretical data found in the literature for iron, glass, polystyrene, and rosin agree well with measurements. F. LACHMAN

534.22

130. Measurement of dispersion of velocity of sound in liquids. E. L. Carstensen. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 858–61 (*Sept.*, 1954).

A technique for the direct measurement of the difference between the velocity of sound in two liquids is described. By choosing for a reference a dispersionless liquid, such as water, the technique becomes a sensitive method for measurement of the change of velocity with frequency in the test liquid. In practice the method is sufficiently sensitive for changes in the velocity smaller than one part in 10^4 to be detected. Illustrative measurements are presented for an NaCl solution, sperm oil, and evaporated milk. A.

534.22 : 536.55

131. Ultrasonic temperature measurement in internal combustion engine chamber. J. C. Livengood, T. P. Rona and J. J. Baruch. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 824–30 (*Sept.*, 1954).

A method and apparatus for measuring the velocity of propagation of sound in the gases within the combustion chamber of an operating internal combustion engine are described. Two barium titanate crystals are used to generate and receive transient acoustical signals of approximately 2 Mc/s. A calibrated commercial oscilloscope is the time-base of the system. From the value of the velocity of sound it is possible to compute the temperature of the portion of the engine gas which lies in the measuring path, provided it is permissible to assume that the gas mixture behaves like a perfect gas, that it is of known composition, and that thermal relaxation effects are negligible. The maximum error is estimated at 4·7% and experiments indicate a dispersion of results less than 1%. A.

534.23

132. The absorption of ultrasonic vibrations in rubber. L. A. Shinyanskiĭ. *Zh. tekh. Fiz.*, **24**, *No.* 5, 851–3 (1954) In Russian.

Assuming an exponential decay in the intensity of a propagated wave, the value of the exponent is measured for various samples of rubber having different constitutions. A linear dependence is found between the values of the exponent and both the vulcanization time and the percentage elongation.

S. C. DUNN

534.23 : 532.13

Vorticity generated by sound. *See Abstr.* 91

534.23 : 532.13

Acoustic experiments relating to the coefficients of viscosity of various liquids. *See Abstr.* 92

534.23 : 532.13

Acoustic streaming in liquids. *See Abstr.* 93

534.23 : 532.13

Ultrasonic measurements and the second viscosity of carbon disulphide. *See Abstr.* 94

534.23 : 532.7 : 541.62

133. Investigation of rotational isomers with ultrasound. J. Karpovich. *J. chem. Phys.*, **22**, *No.* 10, 1767–73 (*Oct.*, 1954).

Sound absorption measurements in organic liquids have revealed relaxation processes in some cyclohexane derivatives, cyclohexene, methyl formate, ethyl acetoacetate, acetic anhydride and methyl benzoate. Additional absorption measurements have been made in the relaxation regions of formic acid, ethyl formate, methyl acetate, and ethyl acetate. A study of cyclohexane derivatives and other similar ring molecules has led to the identification of the mechanism responsible for the relaxations in these liquids. The relaxation phenomena are attributed to the disturbance by the sound wave of equilibria between rotational isomers. The restricted rotation occurs about the single bonds in the ring during the conversion from one chair configuration to another. The relaxation in cyclohexene is caused by the disturbance of the equilibrium between pseudochair and boat configurations, again involving rotation about single C–C bonds. The relaxations in esters of the carboxylic acids are attributed to rotational isomers which arise from rotation about C–O bonds. Infrared absorption bands at about 1160 and 1185 cm^{-1} in the formates and acetates are identified with rotational isomers of the type postulated for the relaxations in these liquids. A.

534.23 : 535.42

134. Ultrasonic absorption constant in liquids by an improved optical method. S. Parthasarathy and M. Pancholy. *Z. Phys.*, **138**, *No.* 5, 635–9 (1954).

The optical diffraction set-up as originally employed by Debye and Sears and Lucas and Biquard has been used with various modifications to estimate the

intensity of sound fields at two or more points along the axis of an ultrasonic beam travelling in a liquid and thereby to determine the absorption coefficient of the liquid medium. Almost all these methods involve a two-step operation with the attendant possibility of errors due to variation in the conditions under which the two observations are made. In the method here reported two axially parallel beams of parallel monochromatic light are made to traverse the liquid normally to the direction of propagation of the sound beam and the resulting diffraction spectra are brought to focus on a common photographic plate. Sound intensities at two points separated by a known distance are thus measured simultaneously under identical conditions. Absorption coefficients calculated for half a dozen liquids by this method are reported. The values compare very favourably with those obtained by other precision methods. A.

534.232

135. An experimental study of polarization effects in barium titanate ceramics. T. F. Hueter, D. P. Neuhaus and J. Kolb. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 696–703 (*Sept.*, 1954).

The electromechanical coupling in barium titanate ceramics is studied as a function of external bias for thickness resonances in the ultrasonic frequency range. The losses associated with the heating of resonant transducers are shown to be primarily of mechanical rather than dielectric origin. The response near coercive field strengths indicates that the rearrangements of domain patterns take place in at least two separate forms. The relationships of the subsidiary responses, which are observed in ceramics under suitable driving conditions, to the state of internal polarization are discussed. Domain processes of the kind assumed in this study furnish an explanation for the observed constriction of dielectric hysteresis loops. A.

534.232 : 621.395.61

136. Unidirectional microphone utilizing a variable distance between the front and back of the diaphragm. A. M. Wiggins. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 687–92 (*Sept.*, 1954).

The front-to-back distance varies approximately inversely as the frequency. The varying relationship is achieved by using two sound entrances with frequency-discriminating parameters. One entrance is situated at a large distance from the front surface of the generating element while the other is placed directly behind the sound responsive element. With this microphone desirable characteristics can be obtained which would not be possible in the conventional cardioid type having a fixed front-to-back distance. The principle of its operation is described and compared with that of the conventional fixed-distance cardioid microphone. A.

534.232 : 621.395.62

137. Distributed transducer for ultrasonic power. J. Rabinow and M. Apstein. *Electronics*, **27**, *No.* 7, 160–2 (*July*, 1954).

A circuit of the distributed-amplifier type was used to produce high-energy travelling waves at ultrasonic frequencies in rods or tubes of magnetostrictive material, the propagation velocity of the circuit delay line matching that of the rod or tube used. The best termination found for the end of the rod or tube not used for power output was of a frictional type. Small Alnico magnets were attached at several points along the rod or tube and a weight was clamped at the end, the clamping force being adjusted to minimize reflections. Transducers of this type are not resonant devices and have wideband characteristics. This was verified by means of a f.m. oscillator providing frequencies of 10·4, 13, 20 and 27 kc/s.

A. Wilkinson (R)

534.232 : 621.395.623.7 : 621.395.61

138. Loudspeakers and microphones. L. L. Beranek. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 618–29 (*Sept.*, 1954).

A review paper which covers the development of loudspeakers and microphones and gives many illustrations of commercially available units dating from 1915 to the present time. A.

534.24

Image interference of underwater sound in calm water. *See Abstr.* 10004 (1954).

534.26

139. Diffraction of an acoustical wave obliquely incident upon a circular disk. H. S. Heaps. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 707–8 (*Sept.*, 1954).

The calculated diffraction pattern behind a circular disk irradiated by an obliquely incident plane wave of sound is compared with that resulting from a normally incident wave. The total sound pressure received by a line receiver is tabulated in terms of its length and position along a certain line. A.

534.321.9 : 669

140. Metallurgical effects of ultrasonic waves. E. A. Hiedemann. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 831–42 (*Sept.*, 1954).

This survey, including scientific and technological literature, deals with the following: A. The techniques for the treatment of melts by mechanical vibrations. 1. Mechanical vibrators. 2. Electromechanical transducers. 3. Ponderomotive effects of induced electrical currents. B. Metallurgical effects observed after ultrasonic treatment. 1. Reduction in grain size. 2. Degassing of melts. 3. Dispersion of other substances in melts. 4. Accleration of rate processes. 5. Other metallurgical and related effects. A.

534.372 : 532.623

141. Damping of pulsating air bubbles in water. M. Strasberg. Letter in *Acustica*, **4**, *No.* 4, 450 (1954).

Remarks on a paper on this subject by Exner and Hampe [Abstr. 2173 (1954)]. These authors refer to anomalous bubbles in which (1) the measured resonant frequency does not agree with the calculated value, (2) the damping at the measured resonant frequency is abnormally low, and (3) the measured resonant frequency may suddenly change. It is now suggested that this anomalous behaviour may be due to surface oscillations of the bubble. It is shown that such surface oscillations may be of the same order of frequency or may even exceed the volume-pulsation frequency. A. B. Wood

534.39 : 577.15.031

142. Heating of haired and hairless mice in high intensity sound fields from 6 to 22 kc. P. A. DANNER, E. ACKERMAN AND H. W. FRINGS. *J. Acoust. Soc. Amer.*, **26,** *No.* 5, 731–9 (*Sept.*, 1954).

Experiments have been conducted to provide a comparison of sound absorption by haired and hairless mice in high-intensity air-borne sound fields. At 18–20 kc/s, threshold intensities for heating of the mice are 144 ± 2 db for haired animals and 155 ± 2db for hairless animals. From 6–22 kc/s, effectiveness of the sound in heating the mice increased with frequency. Absorption coefficients computed from the data are higher at higher frequencies for both types of animals. Death time is dependent upon intensity and frequency of the sound, external covering of the animals, and portion of the animal exposed to the most intense part of the sound field. At frequencies of 18 and 22 kc/s, localized burns were found on hairless animals, and these were studied. The configuration of the sound field and its relation to the results is discussed. Measurements of the field made with and without a hairless mouse showed increased distortion at higher frequencies of the sound field by the body of the mouse. A.

534.512.1

143. Powder ridges in a sound field. M. D. WALLER. Letter in *Nature* [*London*] **174,** 368–9 (*Aug.* 21, 1954).

The author has rediscovered Kundt's original observation that the distance apart of the "ridges" of powder between the nodal lines (or heaps) depends on the size of the particles of the powder. With fine lycopodium spores the ridges are very close together, whereas with coarser sand particles they are more widely separated—varying from place to place along the tube in accordance with the size of the sand particles. These observations may have important implications especially at higher frequencies where the inter-ridge and inter-nodal distances may be comparable. A. B. WOOD

534.612.4

144. Pressure calibration of condenser microphones above 10 000 cps. B. D. SIMMONS AND F. BIAGI. *J. Acoust. Soc. Amer.*, **26,** *No.* 5, 693–5 (*Sept.*, 1954).

A "plane wave" acoustic coupler and an electrical admittance method are described for the pressure calibration of condenser microphones in the ultrasonic frequency range. Calibration results are given for frequencies to 40 kc/s. A.

534.613

145. Absolute measurement of ultrasonic intensity in a liquid by a pendulum method. J. AWATANI. *J. Inst. Elect. Commun. Engrs Japan*, **36,** *No.* 3, 125–9 (*March*, 1953) In Japanese.

The pendulum used consisted of a slender steel bar supported near its centre of gravity and having a circular disk attached to its lower end and a movable counterweight on the upper end. With the disk in an ultrasonic field, the pendulum is deflected by the radiation pressure on the disk. The ultrasonic intensity is determined from the angle of deflection. The method is applicable to the frequency range 10–200 kc/s in water. Measurements were carried out in a non-echoic tank, all the walls of which were covered with securely attached wooden pyramids with apices pointing inwards. The efficiency of a sound source was thus determined. With a prolate spheroid substituted for the disk, the author's theory of acoustic radiation pressure on spheroids was investigated. A. WILKINSON

534.62

146. Resonance reverberation method for sound absorption measurements. J. KARPOVICH. *J. Acoust. Soc. Amer.*, **26,** *No.* 5, 819–23 (*Sept.*, 1954).

A method for liquids, from about 20 kc/s to above 600 kc/s, has been developed. A single spherical glass container holds the liquid under test. The spherical system is excited with an intermittent train of continuous sound waves generated by a piezoelectric element. A second piezoelectric element detects the manner in which the sound energy dies away after the excitation stops. The time constant of this decay is inversely proportional to the sound absorption of the system. The liquid container was calibrated with liquids of known absorption to enable the separation of the wall losses from the liquid absorption. The sound absorption coefficients of 44 liquids are tabulated. Acoustic relaxations which were observed in some of the compounds studied are attributed to the perturbation by the sound wave of equilibria between rotational isomers. The application of the resonance-reverberation technique to sound absorption measurements in solids is presented. A.

534.63

147. New method of determining ultrasonic wavelength in liquid. N. YAMAMOTO. *Rev. sci. Instrum.*, **25,** *No.* 10, 949–50 (*Oct.*, 1954).

A method for the rapid measurement of the velocity of sound in liquids is described. An ultrasonic grating is established in the liquid under investigation. Light from a narrow slit is diffracted in passing through the liquid. It is shown that the wavelength of the sound can be measured by widening the slit until one order of the diffraction spectrum connects with the next. Results of measurements on several liquids are compared with those of other investigators. A.

534.7

Physiological acoustics. Hearing. *See also under* "Medical science. Human physiology." Decimal classification 612.85.

534.771

148. The response of earphones in ears and couplers. M. D. BURKHARD AND E. L. R. CORLISS. *J. Acoust. Soc. Amer.*, **26,** *No.* 5, 679–85 (*Sept.*, 1954).

Applied voltage responses of seven earphones on both ears of fourteen people were obtained with the aid of a probe tube microphone inserted into the volume enclosed by the earphone. Treatment of the response data by the method of analysis of variance allowed separation of variance effects due to error in repeated measurement, dissimilarity between a given person's ears, and differences among individuals. The latter are found to be the most important effects to contend with in audiometric practice. Effects of application force on sound pressure output of an earphone are examined. Comparisons between the average response on ears and on three superficially

different couplers are presented. Responses on ears were substantially different from responses on couplers over parts of the frequency range. Recommendations are given for improving the reliability of audiometric measurements by instrumental refinements. A.

534.781

149. A note on autocorrelation analysis of speech sounds. W. H. Huggins. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 790–2 (*Sept.*, 1954).

By separating a speech wave into its temporal and structural factors, it is possible to reveal concisely and explicitly how the vocal cavity characteristics and the periodicity of the laryngeal excitation enter into the autocorrelation function of the speech wave. This representation provides a simple explanation for the differences between the conventional spectrogram and the correlatogram, such as the marked sensitivity of the latter to variations in pitch and other non-phonemic qualities of the voice, which have been described in a recent paper by Biddulph. A scheme for using cross correlation to avoid the quadratic suppression of weaker components in the auto-correlation function is suggested. A.

534.83

150. Correlation functions for noise fields. J. E. Young. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 788–9 (*Sept.*, 1954).

The autocorrelation function for the noise pressure on the continuous space-time representation is discussed. It is shown that this function is determined throughout the space delay domain by the space correlation. This dependence can be formally interpreted on a causal basis where the delay τ is the "causal variable." Specifically, the values of the space correlation and its time derivative at some instant $\tau = 0$ all over space, serve to specify the autocorrelation for all later delays $\tau 70$ throughout the infinite domain. In the closed domain, the boundary values of the space correlation and its normal derivative are also required to complete the description. A.

534.833

151. Effect of psychological feedback on conversational noise reduction in rooms. T. S. Korn. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 793–4 (*Sept.*, 1954).

In many cases when sound absorptive treatment has been applied to rooms, the effective noise reduction has been found larger than that predicted by the conventional formula. It is shown that this discrepancy appears in cases where conversational noise is predominant, and that it is the result of a phenomenon which may be termed "psychological feedback," which increases the conversational noise reduction (expressed in decibels) by a factor of about 1·6. A.

534.845

152. On sound absorption by cylindrical diffusers. G. Parolini. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 795–7 (*Sept.*, 1954).

For abstract, see Abstr. 10000 (1954).

534.845

153. The multiple panel sound absorber. E. C. H. Becker. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 798–803 (*Sept.*, 1954).

The sound absorber is treated as a complex acoustic circuit in which the number of elements is multiplied to increase the absorption band width, particularly at low frequencies. A convenient form of construction is developed from a uniform array of simple cavity resonators set in a plane wall. Zero and pole frequencies are controlled and reduced relative to construction thickness by discrete addition of branch tanks. A common point technique is used for assessing optimum construction form and damping. Because of the large number of design parameters, use is best made of simple, approximate expressions for circuit elements, tempered by measured relations between standing wave patterns and impedance characteristics. For a given level of required high absorption, construction thickness determines low frequency limit and number of elements determines band width. An example of most favourable construction form is given, the performance of which compares favourably with other absorbers. A.

534.846.4 : 621.395.62

154. Sound systems for large auditoriums. L. L. Beranek. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 661–75 (*Sept.*, 1954).

Gives a comprehensive review of the design of sound systems for large auditoriums. It covers the following subjects: (*a*) when is a sound system necessary?; (*b*) ambient noise effects; (*c*) reverberation effects; (*d*) classification of sound systems; (*e*) behaviour of direct-radiator, multi-cellular, acoustic lens and "column" types of loudspeakers; (*f*) psychoacoustic considerations; (*g*) naturalness; (*h*) loudspeaker arrangements; (*i*) sound system in the large hall of the University City in Caracas, Venezuela; (*j*) sound system in Plenary Hall of the United Nations Headquarters, New York City; (*k*) stereophonic sound system in a municipal theatre; (*l*) distributed "column" sound system in the Holy Cross Cathedral; and (*m*) tests for evaluating sound systems. A.

534.862.3

155. Noise level and mechanical stresses in plastic sound records. E. A. Keller. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 685–7 (*Sept.*, 1954).

Residual mechanical stresses in press-polished plastic film material used for the embossing type sound recording are in many cases responsible for relatively high noise levels. Results of noise measurements of different plastic materials on a 400 grooves per inch recorder are presented. The relation between optically observed stresses and recorded noise level is given. Practical consequences are discussed. A.

534.862.4 : 621.395.623.7

156. Loudspeaker accessory for the production of reverberant sound. D. W. Martin and A. F. Knoblaugh. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 676–8 (*Sept.*, 1954).

Organ music produced in small rooms having little natural reverberation can be enhanced by the addition of artificial reverberation. A direct method of adding the aftersound at the electroacoustic transducer itself is described. This is in contrast to the more conventional reverberation systems employing driving transducers, time-delay means, pick-up transducers, and mixing and amplifying circuits. Multiply resonant helical mechanical delay lines store the energy and radiate it at a later time. In one model

the coupling to the transducer is mechanical, and in the other model acoustical coupling provides a number of practical and acoustical advantages. A.

534.873

157. Propagation of sound in the atmosphere and audibility of warning signals in [the presence of] ambient noise. P. BARON. *Ann. Télécomm.*, **9**, *No.* 10, 258–74 (*Oct.*, 1954) In French.

In an introductory section the author reviews the various factors which affect the long distance propagation of sound in the atmosphere—attenuation (influenced by water vapour content), winds and temperature gradients. A description follows of experiments carried out in "les vals d'Yonne." As sources of sound sirens were used at different heights above the ground, and meteorological records were made of wind, and temperature gradients, which were correlated with the observed signal strengths received. Variations of signal strength were recorded at different distances from the source and at various times of the year. A study was made of the effect of noise, as well as those of wind, on the audibility of the received signals. A. B. WOOD

OPTICS . RADIATION . SPECTRA 535

535.12 : 538.566 : 534.21

Criterion of the applicability of geometrical optics to problems of the propagation of waves through a medium characterized by slight refractive index variations. *See Abstr.* 124

535.23.08

158. Measuring circuit for radiometers. R. P. TEELE. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 860–3 (*Nov.*, 1954).

In using radiometers it is often necessary to measure output voltages as low as a few tenths of a microvolt. Measurement of voltages of this magnitude requires special precautions and measuring technique. The apparatus and method for measuring such voltages with an uncertainty of less than ¼% or 0·001 microvolt are described. The method eliminates the effect of zero and "dark" voltage drift and of parasitic electromotive forces in the measuring circuit. Also the method calibrates the entire amplifier-recorder circuit as a unit and it is, therefore, not necessary either to set exactly or to record the position of any of the controls, the only requirement being the obvious one of leaving them set in position for both calibration and measurement. A.

535.233

159. Methods of representing radiation formulas. W. D. ROSS. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 770–1 (*Oct.*, 1954).

Spectral distribution of radiation intensity may be represented with equal reasonableness for equal increments of wavelength, of wave number, or of logarithmic units. The three methods show maxima at different wavelengths. The most clearly descriptive type of plot shows simply the cumulative energy up to a given wavelength against the logarithm of wavelength. The Wien maximum should be de-emphasized. A.

535.234

160. The maximum of the Planck energy spectrum. R. N. BRACEWELL. Letter in *Nature* [*London*] **174**, 563 (*Sept.* 18, 1954).

For a given temperature, the Planck energy density has a maximum at a spectral location which depends on whether energy density is defined as energy per unit range of wavelength or per unit range of frequency. This note discusses methods of defining energy density such that the location of the maximum does not depend on whether a wavelength or a frequency basis is used. P. M. DAVIDSON

535.247

161. Research on light measurement with a receptor of pre-determined spectral sensitivity. H. KORTE AND M. SCHMIDT. *Lichttechnik*, **6**, *No.* 10, 355–9 (*Oct.*, 1954) In German.

Describes a photometer based on the dispersion and mask principle, using a photomultiplier cell as the receptor. The light to be measured is emitted from an extended diffusing surface. This is placed in the position at which a spectrum would be formed by the entrance slit of a spectrometer, so that a cell placed over the slit receives light of different wavelengths from different parts of the surface. A template is placed over the surface to weight the various wavelengths in such a way as to change the spectral sensitivity of the receptor to conform with any desired curve, e.g. V_λ, the distribution coefficients, etc. Instead of a template a rotating sector with suitably shaped aperture may be used. Tests for accuracy, including a test for additivity, are described.

J. W. T. WALSH

535.247.4

162. Simple glare meter. V. J. JEHU. *Electronic Engng*, **26**, 359–60 (*Aug.*, 1954).

Describes an instrument for measuring the illumination received from the headlights of an approaching car at the instant when the car is 100 yards from the observer. The light falls on a photomultiplier cell situated in the position of the driver's eye in a stationary car facing the oncoming car. By means of a detector tube the approaching car, when it is just 100 yards from the cell, causes a c.r.t. to indicate the value of the photocurrent. The cell has a colour filter to correct its spectral sensitivity. The estimated accuracy is +15 and −8%. J. W. T. WALSH

535.31 : 538.56

163. Stepwise transition from wave optics to ray optics in inhomogeneous anisotropic absorbing media. III. Group propagation. K. SUCHY. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 412–25 (1954) In German.

For Pt II, see Abstr. 6455 (1954). The method of stationary phase is employed to obtain expressions for the period, direction and velocity of group-propagation. To make the specialization to e.m. waves propagated in an inhomogeneous, anisotropic, absorbing medium, the curvature and polarization conditions obtained in Pts I and II have to be assumed. The conditions are discussed under which the time-averaged Poynting vector and the direction of propagation of a wave-group are the same.

H. H. HOPKINS

535.317 : 535.41

164. Properties of an optical system incorporating a zone diaphragm. S. M. Raĭskiĭ [Rayski]. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1(7) 95–7 (1953) In Russian.

It was shown in a previous paper [*Uspekhi fizicheskikh Nauk*, **47**, 515 (1952)] that optical systems consisting of a lens (or mirror) and a zone plate have 3 bright foci, viz. one principal and two zone foci. This enables a sharp focusing of the image of 3 parts of an object (e.g. its front, middle and rear) to be effected in the plane of observation. By using a suitable zone plate it is possible to treble the sharpness of the image. Some peculiarities of the image observed and the conditions under which it can be obtained are described. F. LACHMAN

535.323 : 537.312.5

Optical properties of indium antimonide. *See Abstr.* 300

535.33.07

165. The luminosity of spectrometers with prisms, gratings, or Fabry–Perot etalons. P. Jacquinot. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 761–5 (*Oct.*, 1954).

Formulae have been established which express the flux given by a spectrometer as a function of the effective resolving power and of the dimension of the dispersive system (area of the base of the prism, or area of the grating, or area of the plates of the étalon). It is thus possible to compare the luminosities of the three types of instruments with, in each case, equal resolving power and equal dimension. This comparison reveals a great superiority of the grating over the prism for all regions of wavelengths, and a great superiority of the étalon over the grating. In the case of the étalon, the overlapping may be overcome by the use of several étalons in series. A.

535.33.07

166. Cine spectrograph. D. J. Lovell, H. S. Stewart and S. Rosin. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 799–803 (*Oct.*, 1954).

To study time varying spectral characteristics, a spectrograph has been devised capable of recording successive spectra of an object on continuously driven 70 mm film. Each of the 5000 exposures per second recorded by the instrument consists of five spectra recorded simultaneously. Four of these are of the selected source, with the fifth being of a tungsten source to provide spectral calibration of the film. The film is brought out of a magazine, past a film drum, and on to a take-up spool. The drum has sprocket teeth which engage a length of film in the neighbourhood where exposures are made. Attached to the drum is a skirt in which are cut eighty slanting slots. These rotate directly in front of a slit assembly consisting of five parallel slits each fitted with a neutral density filter. The slots act as a shutter, admitting light only through the areas of the slits exposed by a slot. Since unit magnification optics are used, the image travels with the film. Spectrograms of sources available in the laboratory are discussed. A.

535.33.07–14

167. A simple high-temperature microwave spectrograph. P. A. Tate and M. W. P. Strandberg. *Rev. sci. Instrum.*, **25**, *No.* 10, 956–8 (*Oct.*, 1954).

A microwave absorption cell of simple construction has been designed to work in the temperature range of 600°C to 1000°C. The cell consists of a piece of stainless steel waveguide equipped with a Stark septum and enclosed in a Vycor envelope. The furnace and temperature control equipment used with the cell are described. Electronic detection equipment is similar to that used with other Stark-modulation microwave spectrographs. A.

535.337 : 535.338.32 : 537.527.5

168. An experimental investigation of the broadening of resonance terms. P. Gerthsen. *Z. Phys.*, **138**, *No.* 5, 515–28 (1954) In German.

The width of the infrared Hg line 10 140 Å ($2^1P_1 - 2^1S_0$) was measured with a 1 m concave grating for high-pressure (6–20 atm) arc sources. The data were used with similar measurements of the width of the Hg line 5770 Å ($2^1P_1 - 3^3D_2$). Allowance was made for the arc structure and the effect of impact broadening by electrons was also assessed. J. D. CRAGGS

535.338–15 : 537.527.5

169. A proposed explanation of the longest wavelength infrared emission from the high-pressure mercury discharge. F. Rössler. *Z. Phys.*, **139**, *No.* 1, 56–65 (1954) In German.

A further discussion of the continuum observed with high pressure mercury arcs (and with Zn and Cd discharges) for wavelengths ~100–400 μ. The continuum is explained in terms of "quasi-molecules" and a potential energy diagram involving various excited states is shown to illustrate the argument.

J. D. CRAGGS

535.338.3

170. The measurement of the oscillator strength of O I lines in water-stabilized arcs. G. Jürgens. *Z. Phys.*, **138**, *No.* 5, 613–22 (1954) In German.

Describes the theory and practice of the methods involved in the use of arc sources (in this case the Kiel water turbine discharges) for quantitative spectroscopy. Relative intensities of some 18 O I lines (lying between 3947 Å and 8230 Å) were measured and the oscillator strengths (f numbers) of the various transitions deduced. The results are compared with theoretical values (Bates and Damgaard, etc.).

J. D. CRAGGS

535.338.3

171. On the isotope shift in the Nd II spectrum. G. Nöldeke and A. Steudel. Note in *Naturwissenschaften*, **41**, *No.* 14, 332 (1954) In German.

Experimental values for the isotope shift in the 4012·250 Å line of Nd II are given, also the ratios of these to the calc. values. For atoms with the same numbers of neutrons both Nd and Sm show very similar ratios. S. T. HENDERSON

535.338.3

172. The third spectrum of nickel (Ni III). A. G. Shenstone. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 749–59 (*Oct.*, 1954).

A nearly complete analysis of the third spectrum of nickel is given, based on 800 measured lines extending from 600 Å to 3000 Å. The 168 levels given include all but ^1S from $3d^8$, and all but the higher ^1D from $3d^7\,4s$. The discovery of the higher ^3D is noteworthy. High even levels allow the calculation

of an ionization potential = 36·16 V. The group of odd levels due to $3d^7\,4p$ lacks only a few of low J and some members of $3d^6\,4s\,4p$ are present. The important term $3d^6\,4s^2\,{}^5D$ has not been found. Intensities are very irregular, especially where terms from different families are involved. A.

535.338.3

173. Interference measurements in the spectrum of mercury. G. R. FOWLES. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 760 (*Oct.*, 1954).

Fabry–Perot spectrograms of some twenty lines of Hg I in the visible region have been obtained using as a source an electrodeless discharge tube containing pure mercury vapour. The measurements permit accurate evaluation of the higher odd P terms. A.

535.338.3–15

174. The first spectrum of iodine in the region between 0·8 and 2·2 μ. F. E. ESHBACH AND R. A. FISHER. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 868–9 (*Nov.*, 1954).

The infrared spectrum of iodine, excited in an electrodeless lamp, has been observed in the region between 0·8 and 2·2 μ. Wave-number and intensity measurements have been made on thirty-one lines with an infrared recording spectrograph. Several new levels, probably derived from the $5p^4\,6p$ configuration, are indicated by these new measurements. A.

535.338.332 : 539.152.2

175. High-frequency transitions in the 7 $P_{3/2}$ term of the Cs atom and determination of the quadrupole moment of the Cs^{133} nucleus. K.-H. ALTHOFF AND H. KRÜGER. *Naturwissenschaften*, **41**, *No.* 16, 368–9 (1954) In German.

The hyperfine structure transitions in the $7\,P_{3/2}$ state are observed from the effect of h.f. radiation on the depolarization of the resonance spectrum with polarized exciting light. In low h.f. fields the transitions $F_{2\leftrightarrow 3}$ at 49·85, $F_{3\leftrightarrow 4}$ at 66·45 and $F_{4\leftrightarrow 5}$ at 82·85 ± 0·05 Mc/s are observed. These values show very small departure from pure magnetic coupling and lead to $-0{\cdot}003 \pm 0{\cdot}002\times10^{-24}$ cm² for $Q(Cs^{133})$. D. H. WHIFFEN

535.338.334

176. Pressure-broadening of the yellow sodium lines in the acetylene flame. L. HULDT AND E. KNALL. *Z. Naturforsch.*, **9a**, *No.* 7–8, 663–7 (*July–Aug.*, 1954) In German.

A photoelectric study of line-profiles of the Na doublet at 5893 Å in the spectrum of an air-acetylene flame, sprayed with aqueous NaCl solutions of varying concentrations, reveals a linear relation between total emission intensity and log concentration NaCl. Analysis of profiles corresponding to concentrations, 10^{-3}, 10^{-2}, 10^{-1} and 1 mol/litre shows that self-absorption sets in at a NaCl concentration between 10^{-2} and 10^{-1} mol/l; and that, within the core of the line-profile, the change of absorption coeff. with λ agrees well with theory when account is taken of the overlying Doppler- and Lorentz-contours. D. R. BARBER

535.338.334

177. Pressure broadening of OCS in foreign gas mixtures. F. A. LIUIMA, A. V. BUSHKOVITCH AND A. G. ROUSE. *Phys. Rev.*, **96**, *No.* 2, 434–5 (*Oct.* 15, 1954).

Line widths of the $J = 1 - 2$ OCS line in mixtures with foreign perturbing gases have been measured. The perturbers were N_2O, He, and O_2 in three different percentages of mix, about 20%, 50% and 75% of perturber. Systematic variation of collision diameters with mix ratio, previously reported, was not observed. A.

535.343.2/.3–31

178. Assignment of the intense 'acene absorption systems. D. P. CRAIG, P. C. HOBBINS AND J. R. WALSH. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1616–17 (*Sept.*, 1954).

The absorption region at 2500 Å of anthracene in solution and the bands at 2700 Å (polarized along the b monoclinic axis), and at 2300 Å (polarized in the ac plane) are investigated. These crystal absorptions have no connection with the weak 2300 Å absorption of the solution: both crystal systems must arise from splitting of the 2500 Å solution band. The experimental data agree with the expected values for a long-axis transition: the intensity ratio of the components also agrees. This is confirmed by the polarized spectrum of tetracene, which is triclinic, though nearly monoclinic. The transition is assigned as $A_g - B_{3u}$. A. J. TAYLOR

535.343.2

179. Absorption band at 2·72 μ of vitreous silica. V. GARINO-CANINA. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 12, 705–6 (*Sept.* 20, 1954) In French.

This band is present whenever water is present during fusion and is attributed to OH groups in the lattice. G. F. LOTHIAN

535.343.2 : 535.372

180. Excited states of the naphthalene molecule. I. Symmetry properties of the first two excited singlet states. D. S. MCCLURE. *J. chem. Phys.*, **22**, *No.* 10, 1668–75 (*Oct.*, 1954).

The detailed polarization properties of the bands in absorption and fluorescence spectra of the naphthalene molecule have been determined by a method which makes use of a substitutional solid solution of naphthalene in durene. A single crystal of about 0·1% naphthalene in durene was cut so that the short axes of the naphthalenes lie strictly parallel to the surface and in one direction. The spectra were then determined in polarized light at 20°K under moderately high dispersion. The results clearly indicate that the first state is ${}^1B_{3u}$ (the transition from the ground state is long-axis polarized) and the second ${}^1B_{2u}$. Vibrational-electronic interaction involving b_{1g} vibrations apparently couples the first state with the second, and this results in a large short-axis polarized transition moment. This fact has been at the root of most of the previous difficulties with analysis of the spectra. A.

535.343.2 : 541.14

181. Absorption spectrum and photochemistry of silver halide crystals with sulphur, selenium and tellurium additions. C. VOLKE. *Z. Phys.*, **138**, *No.* 5, 623–34 (1954) In German.

Ag_2S and Ag_2Se can be added to AgCl and AgBr but Ag_2Te will only dissolve in AgBr. At −186°C crystals with these additives show a sharp absorption band dependent in position on the additive and on

the lattice constant. The photochemical behaviour of the AgCl–Ag_2Se and the AgBr–Ag_2Se crystals is investigated at low temperatures. G. F. J. GARLICK

535.343.2–31

182. The polarized ultraviolet spectrum of tetracene single crystals by a photoconductance method. A. BREE AND L. E. LYONS. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1630 (*Sept.*, 1954).

Single crystals of some aromatic compounds become photoconducting when irradiated with light of absorption-band frequency. This fact is used for the determination of the absorption spectrum of tetracene. Linearly polarized light was used. The photoconductance curve found shows that the polarization of the first system is in the *b* direction, which agrees with spectral results. The second and third systems, not yet investigated spectrographically, are found to be slightly polarized along the *b* direction. The ratio of the peak currents indicates that the transitions are polarized along the long molecular axis. A. J. TAYLOR

535.343.3–31

183. On the absorption of nitrobenzene. A. WENZEL. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1623–4 (*Sept.*, 1954).

The ultraviolet absorption spectrum is interpreted. It is suggested that the 40 000 cm^{-1} band and the hidden band at 34 500 cm^{-1}, which is only shown as an inflection, but becomes visible in substituted nitrobenzenes, correspond to the benzene bands at 48 000 cm^{-1} and 39 000 cm^{-1} respectively. Evidence for this is, that from these nitrobenzene bands the bands of β-nitronaphthalene can be predicted correctly. The weak band at 28 600 cm^{-1} must be due to the NO_2 group. A. J. TAYLOR

535.343.32/.4–32

184. Vacuum ultraviolet absorption spectra of iodine and bromine. N. S. BAYLISS AND J. V. SULLIVAN. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1615–16 (*Sept.*, 1954).

These spectra were taken of the gases and in solution in the region near 2000 Å. The molar extinction coefficients are tabulated. Both iodine and bromine have maxima near 54 000K, but the spectra of the solutions are complex and consist of several overlapping transitions. The gas spectra are much more intense. There must either be a large solvent displacement or the solvent perturbation decreases the transition probability in solution. A. J. TAYLOR

535.343.4

185. Intensities in band systems of O_2 : $^3\Sigma_u^+ - {}^1\Sigma_g^+$ (Broida–Gaydon system) and $^1\Sigma_g^+ - {}^3\Sigma_g^-$ (atmospheric system). M. E. PILLOW. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 9, 847–9 (*Sept.*, 1954).

Calculations of vibrational intensity distribution have been made and are compared with visual estimates from published experimental data. The reality of the new Broida–Gaydon system is confirmed. The intensity of the (1, 1) band in atmospheric absorption suggests a temperature of at least 240°K. A. G. GAYDON

535.343.4–14

186. Effects of internal motion in the microwave spectrum of methyl amine. D. R. LIDE, JR. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1613 (*Sept.*, 1954).

32 lines of the spectrum are interpreted in terms of the quantum numbers $JK\tau\gamma$ of the states concerned, taking account of internal rotation and inversion doubling. D. H. WHIFFEN

535.343.4–14

187. Saturation in the microwave spectrum of methyl chloride. G. R. BIRD. Letter in *Phys. Rev.*, **95**, *No.* 6, 1686 (*Sept.* 15, 1954).

Power saturation was observed for the $J_{0\to1}$ lines of CH_3Cl^{35} and agreement with the line breadth constant $\Delta\nu/p$ of 21 ± 1 Mc/s per mm of Hg at 300°K shows that the collisions for line broadening and for energy transfer are identical. The hard sphere collision diameter is 16·1 Å indicating that dipole-dipole interactions are involved. D. H. WHIFFEN

535.343.4–14

188. Microwave absorption by the nonpolar gas CO_2. G. BIRNBAUM, A. A. MARYOTT AND P. F. WACKER. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1782 (*Oct.*, 1954).

At 45 atm and 25°C, CO_2 has absorption $1{\cdot}4\times10^{-4}$ cm^{-1} at 1·29 cm and $2{\cdot}3\times10^{-5}$ cm^{-1} at 3·30 cm. In this range the loss is proportional to the square of the density and it is suggested that the effect is due to dipoles induced by the quadrupoles of the nearby molecules. D. H. WHIFFEN

535.343.4–14

189. Microwave spectra of the alkali halides. A. HONIG, M. MANDEL, M. L. STITCH AND C. H. TOWNES. *Phys. Rev.*, **96**, *No.* 3, 629–42 (*Nov.* 1, 1954).

Data from the microwave spectra of all alkali halides excepting LiF, NaF, KF, RbF and LiCl are given and analysed in terms of molecular and nuclear constants. These yield internuclear distances and ionic radii for the gaseous alkali halides, molecular dipole moments, potential constants including four constants for some molecules, amount of covalent character from quadrupole coupling constants and from rotational effects and mass ratios for isotopes of Li, K, Rb, Cl and Br. A.

535.343.4–14 : 539.132

190. Millimeter wave spectra and centrifugal stretching constants of the methyl halides. W. J. O. THOMAS, J. T. COX AND W. GORDY. *J. chem. Phys.*, **22**, *No.* 10, 1718–22 (*Oct.*, 1954).

High *J* transitions of the methyl halides have been measured and have been used to calculate accurate values for the centrifugal distortion constants. The values obtained for B_O, D_{JJ} and D_{JK} are (in Mc/s and kc/s, respectively); $CH_3.F^{19}$, 25 536·11, 59·3, 445; $CH_3.Cl^{35}$, 13 292·86, 18·1, 198; $CH_3.Br^{79}$, 9568·20, 9·9, 128·3; $CH_3.Br^{81}$. 9531·82, 9·7, 127·4; $CH_3.I^{127}$, 7501·30, 6·28, 98·5. The new D_{JJ} value for $CH_3.Cl^{35}$ is in good agreement with the value of 18·4 kc/s theoretically predicted by Chang and Dennison. For all four molecules the D_{JJ} constants were found to be in good agreement with those predicted from Kratzer's formula $D_{JJ} = 4B_O^3/\omega^2$, where ω is the vibrational frequency corresponding to the stretching of the carbon halogen bond. A.

535.343.4–14 : 539.133

191. Microwave spectrum of formic acid. R. TRAMBARULO AND P. M. MOSER. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1622–3 (*Sept.*, 1954).

Transitions in HCOOH and HCOOD are identified and are consistent with a planar structure C = O 1·22,

C – O 1·34, O – H 0·97, C – H 1·09 Å. ∠H – C = O 121·7°, ∠O – C = O 124·8° and ∠C – O – H 105·5° and the H atom cis to =O. D. H. WHIFFEN

535.343.4–14 : 539.133

192. Microwave spectrum and properties of vinylene carbonate. G. R. SLAYTON, J. W. SIMMONS AND J. H. GOLDSTEIN. *J. chem. Phys.*, **22**, *No.* 10, 1678–9 (*Oct.*, 1954).

The microwave spectrum of vinylene carbonate has been investigated in the region from 19 000 to 32 000 Mc/s. Eight *R*-branch transitions have been identified and fitted with the following spectroscopic parameters: $a = 9346{\cdot}79$ Mc/s, $b = 4188{\cdot}46$ Mc/s, $c = 2891{\cdot}54$ Mc/s, all $\pm 0{\cdot}10$ Mc/s; $\kappa = -0{\cdot}59818$. The dipole moment of the vapour, as determined from Stark effect studies, is $4{\cdot}51 \pm 0{\cdot}05D$ and lies in the *a*-axis. The molecule has been shown to be planar. The significance of these results is discussed. A.

535.343.4–15

193. Simultaneous vibrational transitions in the infrared absorption spectra of compressed gases. J. FAHRENFORT AND J. A. A. KETELAAR. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1631–2 (*Sept.*, 1954).

The infrared spectrum was taken of a mixture of CO_2 (pressure 20 atm) and N_2, with total pressure 75 atm. Two bands (2994 cm^{-1} and 4670 cm^{-1}) were observed which do not appear in spectra of the pure gases. These are explained as collision complexes of the 667·3 cm^{-1} and 2349 cm^{-1} fundamentals of CO_2 with the 2330·7 cm^{-1} fundamental of N_2. Analogous bands were found in CO_2–O_2 and CO_2–H_2 mixtures. The former showed a band at 3895 cm^{-1} which can be attributed to the combination of the 2349·3 cm^{-1} (CO_2) and 1554·7 cm^{-1} (O_2) fundamentals, the latter a band at 6505 cm^{-1}, attributed to 2349·3 cm^{-1} (CO_2) and 4160·2 cm^{-1} (H_2). A. J. TAYLOR

535.343.4–31

194. The absorption spectrum of bismuth selenide and bismuth telluride in the region 2900–2200 Å. C. B. SHARMA. *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 935–8 (*Oct.*, 1954).

Several new band systems have been observed in the absorption spectra of BiSe and BiTe molecules in the vapour state at high temperatures (1000° to 1300°C). The band-heads have been analysed and constants obtained. A.

535.345

195. The transparency of cellulose acetate, cellophane, nylon, mylar, and teflon in the region 3–10 Å. A. E. SANDSTRÖM AND B. NORDFORS. *Ark. Fys.*, **8**, *Paper* 11, 147–9 (1954).

Transmissions are measured for films of 1, 5 and 10 μ thickness. Nylon is the most transparent with absorption coefficient $= 1200$ cm^{-1} at $\lambda = 10$ Å. G. F. LOTHIAN

535.345–15

196. Anomalous optical behavior of InSb and InAs. H. J. HROSTOWSKI, G. H. WHEATLEY AND W. F. FLOOD, JR. Letter in *Phys. Rev.*, **95**, *No.* 6, 1683–4 (*Sept.* 15, 1954).

Transmission spectra are presented for samples of InSb doped with varying amounts of Te. The extrinsic electron densities, n, vary from $5 \cdot 10^{15}$ cm^{-3} to $\sim 10^{19}$ cm^{-3}. The optical energy gap is shown to vary with n from 0·18 eV for the purest to $\sim$0·6 eV for the heavily doped samples, in general agreement with the theory of Burstein [Abstr. 6498 (1954)], although for complete agreement an assumption of a still smaller effective mass for electrons in pure InSb is required. Similar optical effects, though smaller in magnitude, have been observed in InAs. D. G. AVERY

535.354

197. Measurements of lifetimes of excited states of atoms by the method of delayed coincidences. S. HERON, R. W. P. MCWHIRTER AND E. H. RHODERICK. Letter in *Nature* [*London*] **174**, 564–5 (*Sept.* 18, 1954).

Helium at a pressure of $\sim 0{\cdot}01$ mm Hg was excited by an electron beam, pulsed so that the beam was incident for 2×10^{-8} sec (10^4 times/sec), and the delayed light emission from atoms excited in the beam was detected with a photomultiplier tube. A coincidence circuit with variable delay gave a measure of the rate of decay of radiation intensity with time from which lifetimes may be deduced. J. D. CRAGGS

535.371

198. The dependence of some luminescent properties of the phosphors SrS–Ce, Sm and SrS–Eu, Sm on the wavelength of the exciting light. Z. I. MORGENSHTERN. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4(10) 491–7 (1953) In Russian.

A study of the dependence of the limiting quantity of light stored up by the above substances, as function of the wavelength (in the range $\lambda = 250$ to 600 mμ) of the intense irradiating light. (The limit comes about because of re-emission induced by the irradiation itself.) A small correction for the non-uniform irradiation of the thin (0·1–0·03 mm) samples (due to absorption) was applied. For SrS–Eu, Sm there are 2 maxima ($\lambda \sim 300$ and 500 mμ), for SrS–Ce, Sm one at 300 mμ and a small one at 440 mμ. This dependence is paralleled by that of the coefficient of absorption on λ [Abstr. 6649 (1953)]. The significance of this for the mechanism of re-emission is discussed. The spectrum of light stored in SrS–Ce, Sm under irradiation by $\lambda = 546$ mμ or 435 mμ, and re-emitted under irradiation with infrared light was also photographed by depositing the substance on a slowly rotating cylinder, the irradiation and re-emission taking place on opposite sides. W. J. SWIATECKI

535.371

199. On the monochromatical excitation of the fluorescence in tetrahydrofluorocyclene solutions. Z. MAŁKOWSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 7, 287–91 (1953).

Changes in spectral distribution of emission are observed for changes in nature of the solvent and of the wavelength of exciting radiation. In CCl_4 photochemical action removes the shorter wavelength emission bands. G. F. J. GARLICK

535.371

200. Band-width problems in the investigation of relaxation processes. G. GERGELY. Note in *Acta phys. Hungar.*, **4**, *No.* 1, 87–9 (1954).

A theoretical discussion is given of the frequency and phase distortions in compensation methods for measuring exponential rise and decay of luminescence.

For most phosphors the effect of these distortions is negligible. See Abstr. 7916 (1952). G. F. J. GARLICK

535.371

201. Existence of two types of infra-red luminescence centres due to copper in cadmium sulphide. E. GRILLOT AND P. GUINTINI. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 5, 418–20 (*Aug.* 2, 1954) In French.

535.371

202. Optical properties of a new luminescent substance with a base of antimony oxide Sb_2O_4. R. BERNARD AND J. JANIN. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 6, 489–90 (*Aug.* 9, 1954) In French.

Sb_2O_4 activated by Mn is excited by radiation <3500 Å to orange luminescence with a band peak at 6300 Å. This emission is unchanged in position between $-60°$ and $+20°$C, but the max. total emission occurs near 0°C for 3130 Å excitation, and at $-20°$C for 2537 Å. The thermoluminescence shows a single peak at $-60°$C. S. T. HENDERSON

535.371

203. Electron trap distributions in phosphors. J. M. HONIG. *J. chem. Phys.*, **22,** *No.* 10, 1689–92 (*Oct.*, 1954).

The possible interpretation of long life-time phosphorescence decay in terms of the electron trap mechanism is briefly reviewed. It is then shown how the distribution of activation energies among filled traps may be computed from the experimentally observed decay curves. The decay curves can be expressed as a Laplace transform of the distribution density function for activation energies, and the latter can then be calculated by inversion of the transform. Several examples are given in illustration of the procedure. The limitations inherent in the procedure are briefly discussed, and it is pointed out how the method might be used to test the applicability of the simple electron-trap model to experimental data. A.

535.371

204. Fluorescence of nitrogen dioxide. D. NEUBERGER AND A. B. F. DUNCAN. *J. chem. Phys.*, **22,** *No.* 10, 1693–6 (*Oct.*, 1954).

The mean lifetime of fluorescence of NO_2 vapour was measured at pressures in the range 12 to 0·6 microns by a direct electronic method. A linear dependence of lifetime on pressure was found, and extrapolation to zero pressure gave 44 microseconds for the lifetime in absence of collisions. The fluorescence spectrum in the region 4600–8000 Å was photographed with 4358 and 5461 Å excitation, with somewhat different results. Interpretation of the results appears to require two excited electronic levels, one of which is not connected optically with the normal state and which is responsible for the long-lived fluorescence. A.

535.371

205. Light output of luminescent plastics. W. A. THORNTON. *Phys. Rev.*, **96,** *No.* 2, 292 (*Oct.* 15, 1954).

Efficiency of transfer of excitation energy from solvent to solute in a luminescent plastic solid solution is derived and compared to a previously published expression. Capture cross-section ratios and the nature of the quenching parameter are discussed. A.

535.371

206. Afterglow of magnesium oxide single crystals. E. YAMAKA. *Phys. Rev.*, **96,** *No.* 2, 293–6 (*Oct.* 15, 1954).

Magnesium oxide single crystals have been irradiated with ultraviolet light at room temperature and the glow curves and accompanying electric current recorded simultaneously from room temperature to 300°C. The measurements of optical absorption show the disappearance of absorption bands in visible region. Trap depths of the luminescent centres are given. A.

535.371

207. Scintillation response of phosphors at low particle energies. G. T. WRIGHT. *Phys. Rev.*, **96,** *No.* 3, 569–70 (*Nov.* 1, 1954).

The results of a detailed statistical analysis of the scintillation counter are used to correct previously published data for the response to low-energy photoelectrons of NaI(Tl) and anthracene. The nature of the true response curves is discussed. A.

535.371 : 541.64

208. On luminescence in high polymers. I. H. HINRICHS. *Z. Naturforsch.*, **9a,** *No.* 7–8, 617–25 (*July–Aug.*, 1954) In German.

The luminescence of anthracene in polystyrene is dependent on addition before or after polymerization. In the first case there is a strong interaction between fluorescent molecules and host polymer. The wave number of the electron transitions decreases in solution while the vibrational term of the ground state remains unchanged. A decrease in wave number is also observed for prolonged cathode-ray excitation. It is likely that the binding between the anthracene and polystyrene radicals leaves the ring structure of the anthracene intact. G. F. J. GARLICK

535.371 : 541.64

209. On luminescence in high polymers. II. H. HINRICHS. *Z. Naturforsch.*, **9a,** *No.* 7–8, 625–30 (*July–Aug.*, 1954) In German.

For cathode-ray excitation of fluorescent molecules dispersed in polystyrene the fluorescence intensity falls exponentially with electron dosage. For hydroquinone-dicarboxylic acid-diethyl ester in polystyrene the rate of deterioration decreases with concentration of the fluorescent additive is probably due to increase in energy transfer processes. The deterioration of the crystalline form of the fluorescent compound is compared with that of the substance in polystyrene. G. F. J. GARLICK

535.372

210. Luminescent components of petroleum. KH. I. MAMEDOV. Letter in *Zh. éksper. teor. Fiz.*, **26,** *No.* 5, 647–8 (1954) In Russian.

The u.v. luminescence spectrum of Azerbaijan petroleum, excited by the Hg 313 mμ line, has peaks at 348, 368, 382 and 402 mμ, most pronounced in 0·01% solution in organic solvents, and coinciding in position with peaks in the luminescence spectrum of phenanthrene. R. C. MURRAY

535.372

211. Cathodo-luminescence study of (BaSr)O. K. NOGA AND K. NAKAMURA. Note in *J. Phys. Soc. Japan*, **9,** *No.* 3, 435–7 (*May–June*, 1954).

Each band of the cathodo-luminescence spectrum

of (BaSr)O is located between the corresponding bands of the spectra of BaO and of SrO and cannot be represented as a superposition of them. This suggests that (BaSr)O is a true solid solution of the oxides, as has been indicated by others from X-ray measurements, rather than a two-phase mixture of them. A. D. LE CLAIRE

535.372

212. Vibration temperatures in the phosphorescence spectra of Swan bands for the C_2 molecule. G. LUKACS AND L. HERMAN. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 10, 640–2 (*Sept.* 6, 1954) In French. .

A 99% He 1% CO mixture at 3 mm Hg pressure is r.f.-excited by 86 Mc/s pulsed fields of 50 c/s repetition rate (pulse length 10^{-5} sec, power 20 kW). A 3000 r.p.m. phosphoroscope system separates the phosphorescence at 5×10^{-5} sec for spectroscopic study. The "temperature" of vibration is estimated as 15 000°K. Results suggest low collisional loss by C_2 molecules and at least one intermediate electron state in the phosphorescence mechanism. G. F. J. GARLICK

535.375.5

213. Transformation of the observed outline of Raman spectrum line into the true one. M. M. SUSHCHINSKIĬ. *Zh. éksper. teor. Fiz.*, **25,** *No.* 1(7) 87–94 (1953) In Russian.

Presents the general solution of the equation $k(x) = \int_{-\infty}^{\infty} \phi(\lambda)a(x-\lambda)d\lambda$ (where $k(x)$ is the intensity distribution of the spectral line, $\phi(\lambda)$—a function describing the form of the line, and $a(x)$—the "apparatus function," i.e. the distribution of intensity, generated by an infinitely narrow spectral line in the focal plane of the spectrograph). The solution is further modified for Raman spectrum lines; it is found that their true outlines are fully determined by the observed outlines of these lines and of the exciting lines. The results of calculation are used for finding the true outlines of Raman lines in some typical cases. F. LACHMAN

535.375.5 : 548.7

214. Translational vibrations in molecular crystalline lattices, and their appearance in Raman spectra. SH. SH. RASKIN AND F. I. SKRIPOV. *Zh. éksper. teor. Fiz.*, **26,** *No.* 4, 479–91 (1954) In Russian.

From a study of the Raman spectrum of crystalline *d*-tartaric and racemic acids, ethylenediamine, dipotassium and sodium-potassium tartrates, crystalline and liquid resorcin and thymol, and calculations from compressibility, specific heats, Madelung and Lindeman equations, it is concluded that translational frequencies are of the same order as rotational or even slightly higher in some cases, and that translational lines may appear in the Raman spectra of crystalline substances, at any rate if they contain hydrogen bonds. R. C. MURRAY

535.375.55

215. The Raman frequency of liquid bromine. H. STAMMREICH AND R. FORNERIS. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1624 (*Sept.*, 1954).

Excitation by $\lambda = 8115$ Å (argon) gives the Raman line 306 cm^{-1}. G. F. LOTHIAN

535.375.55

216. Relative intensities of the Raman lines of carbon tetrachloride, chloroform, and methylene chloride. H. J. MARRINAN AND N. SHEPPARD. *J. Opt. Soc. Amer.*, **44,** *No.* 10, 815–19 (*Oct.*, 1954).

The construction of a photoelectric Raman spectrometer is briefly described, and the procedure used to determine the intensities of Raman lines is given in detail. The relative intensities of the Raman lines of carbon tetrachloride, chloroform, and methylene chloride in the liquid state have been measured on a uniform scale. The values obtained for the individual molecules CCl_4 and $CHCl_3$ are in excellent agreement with those obtained previously by Rank [Abstr. 300 (1948)] using the photoelectric method. The whole range of intensities on a uniform scale for the three molecules are also in good general agreement with those obtained by Welsh, Crawford, Thomas and Love [Abstr. 6660 (1953)] in the gaseous phase using the photographic method. Only one out of thirteen strong lines has a significant intensity deviation of more than 15% from the mean values of the two sets of results. It is concluded that intensity measurements in the liquid phase for molecules with weak intermolecular forces may sometimes be adequate substitutes for the gaseous measurements that are strictly required for comparison with theoretical calculations. A.

535.375.56

217. On a supposed Raman spectrum of gaseous bromine. R. F. BARROW. *J. chem. Phys.*, **22,** *No.* 10, 1775 (*Oct.*, 1954).

Agreement between theory and experiment is improved by regarding the Raman lines recorded by Stammreich [Abstr. 5727 (1950)] as lines of a resonance fluorescence series. G. I. W. LLEWELYN

535.376

218. A microphotometric measurement of the electroluminescence of silicon carbide crystals. G. SZIGETI, G. T. BAUER AND J. WEISZBURG. *Acta phys. Hungar.*, **4,** *No.* 1, 57–64 (1954) In German.

A microscope is designed with a direct viewing spectroscope and visual photometer attached which enable the electroluminescence emission spectrum of the SiC crystals to be measured with ±15% accuracy. G. F. J. GARLICK

535.376

219. Electroluminescence excited by direct currents in silicon carbide crystals. G. SZIGETI. *Acta phys. Hungar.*, **4,** *No.* 1, 65–78 (1954) In German.

Characteristics of electroluminescence are measured for different temperatures. The luminescence centres are assumed to be excess carbon atoms. An energy level scheme for SiC is proposed. G. F. J. GARLICK

535.376

220. Quantitative measurements of the basic process of light excitation in phosphors by single α-particles. I. BROSER AND C. REUBER. *Z. Naturforsch.*, **9a,** *No.* 7–8, 689–93 (*July–Aug.*, 1954) In German.

For previous paper see Abstr. 6399 (1950). The afterglow decay law is reported to be hyperbolic for ZnS–Ag, ZnS/ZnSe–Ag and ZnS–Cu and exponential for ZnO and for pressure-crushed ZnS–Cu. The

measured constants lead to calculation of transition probabilities in the first case and of concentrations of capture centres in the second. A. SCZANIECKI

535.41

221. Simulator for calculating the reflectance and transmittance of multilayer interference films. S. M. MacNeille and E. O. Dixon. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 805–10 (*Oct.*, 1954).

In this simulator the amplitude and phase of a light wave are represented by the amplitude and phase of an a.c. voltage. Each layer in the film is simulated by a four-terminal network containing adjustable attenuators and an adjustable phase shifter. The network obeys the same difference equation [see, e.g., Abstr. 1837, 3149 (1947)] as that which relates the reflectance of $n + 1$ interference layers to the separate reflectances of the first n layers taken together and of the $n + 1$th layer. With these networks connected in sequence and the circuit parameters adjusted to correspond to the optical constants of the various layers of the film, either the reflectance or transmittance of the multilayer can be read directly on a meter. Since the circuit parameters correspond to (1) reflectance at the interface between layers, (2) phase retardation and (3) attenuation with passage through the layer, the instrument can treat problems involving oblique as well as normal incidence, polarization and absorption. A.

535.41 : 531.711

222. Optical interference with a metre path difference. J. Terrien and J. Hamon. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 8, 586 (*Aug.* 23, 1954) In French.

Success has been achieved in obtaining interference over a path difference of 100 cm using a Michelson interferometer, the source with which this was achieved consists of isolated Kr^{86}, operating in the triple point of nitrogen (63°K). The interference over this long path difference could only be secured in the infrared using the 9856 Å. It was not possible to secure fringes over a metre with the shorter wave 8777 and 9752 Å. It is now possible to compare in one single operation the length of one metre line standard in terms of light waves. S. TOLANSKY

535.417 : 771.534.5

223. Interference filters for photographic densitometry. E. K. Letzer and S. A. Powers. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 870–4 (*Nov.*, 1954).

Colour filters used in densitometry have usually been made of gelatin and glass combinations. During the past few years interference filters have become available which provide greatly improved densitometry because of their inherently greater stability and narrower pass bands. Tricolour and sound track densitometry can at present be very well accomplished employing Fabry–Perot type filters. Multilayer Fabry–Perot filters may prove to be even superior. Fabry–Perot filters can also be used in a colour densitometer to convert it to an abridged spectrophotometer. Excellent near infrared elimination in colour densitometers can be accomplished through means of dichroic filters. A.

535.42

224. Optical diffraction effects produced by amplitude and phase changes in the wave front. G. H. Godfrey. *Austral. J. Phys.*, **7**, *No.* 3, 389–99 (*Sept.*, 1954).

The diffraction which occurs when certain areas of the wave front undergo changes of amplitude or phase or both, relative to the rest of the front, may be readily treated by a method which is virtually a generalization of Babinet's principle. Applications to both Fraunhofer and Fresnel diffraction are given and include phase gratings, striations, haloes, phase-contrast techniques, zone plates and holograms. A.

535.43

225. Optical study of thin films of calcium fluoride in the total reflection zone. P. Bousquet. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 5, 406–8 (*Aug.* 2, 1954) In French.

A thin film is deposited upon the hypotenuse of a totally reflecting glass prism. A series of fringes can be seen in this film which show some marked departures from those expected from theory. This note describes some experiments carried out in polarized light and with films of different thickness and confirms that anomalies occur. R. W. FISH

535.43

226. Reflectance and transmittance of inhomogeneous diffusing layers. Å. S. Stenius. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 804–5 (*Oct.*, 1954).

Starting from equations derived by use of the Kubelka–Munk theory giving general expressions for reflectance, reflectivity and transmittance of inhomogeneous diffusing layers, a means is given to form simple algebraic interrelations between these measurable quantities. It is shown that, in contrast to homogeneous media, equation systems for nonhomogeneous layers cannot be solved for the scattering and absorbing properties even in the simplest case, that of a dual combination of sublayers. Finally, it is pointed out that if the diffusing system is composed of well-defined layers, the interreflections between these layers are a potential source of error, even if the surface reflections of the sublayers are so low that their influence is not detectable by deviations from the Kubelka–Munk theory. A.

535.43 : 551.46

227. Measurement of the roughness of the sea surface from photographs of the sun's glitter. C. Cox and W. Munk. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 838–50 (*Nov.*, 1954).

535.43.07

228. Angular-dependence light scattering—a high-resolution recording instrument for the angular range 0·05–140°. W. H. Aughey and F. J. Baum. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 833–7 (*Nov.*, 1954).

A unique optical instrument for the measurement of light scattering in physically nonhomogeneous systems is described. The scattering data provide a basis for the size characterization of optical inhomogeneities in the radius range 0·1 to 100 μ. The useful angular range of the instrument extends from about 0·05° to 140°. Angular resolution of 0·02° is readily attainable for characterizing large inhomogeneities at small angles. Scanning rates are 0·1, 0·4, 1·0, 4·0 and 20°/min. Light intensities varying by a factor of 10^8 are measured through the use of an optical attenuator which facilitates use of a 1P21 multiplier phototube

at a low level of illumination. The phototube output is charted by a special high-impedance recorder having a full-scale sensitivity of 0·004 μA. Angles are marked by an auxiliary pen on the recorder. A.

535.43.07 : 541.182.2

229. A forward angle light scattering camera for determining size distribution in aerosols. P.-K. Lee and V. K. La Mer. *Rev. sci. Instrum.*, **25**, *No.* 10, 1004–10 (*Oct.*, 1954).

The light scattered in the near forward direction from individual dioctyl phthalate (DOP) droplets flowing in a thin stream of known thickness and illuminated by a high-intensity electronic flash tube is recorded photographically for the determination of number concentration and size-frequency distribution. The photos are taken slightly off-focus so that the pin-point images at focus are expanded into diffraction patterns. The optical density of each pattern is used as a measure of its droplet size. The correlation between optical density and droplet size was determined with a series of aerosol preparations of known size and of size distribution characterized by a standard deviation which is about 10% of the mean. This correlation permits the translation of the measured frequency curve for optical density into a size-frequency distribution. The method has been checked by determining the size-frequency distribution of synthetic mixtures of known size. The reliable range of measurement extends from 0·12 to 0·50 μ radius. A.

535.434

230. Experimental verification of the Mie theory of light scattering. W. Heller, J. N. Epel and R. M. Tabibian. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1777–8 (*Oct.*, 1954).

Turbidity measurements on polymer spheres up to 0·7 μ diameter. G. F. LOTHIAN

535.434

231. On the absolute turbidity of water. R. W. Fessenden and R. S. Stein. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1778–9 (*Oct.*, 1954).

Measurements in dilute salt solutions extrapolated to zero concentration, for $\lambda = 5461$ Å. G. F. LOTHIAN

535.435

232. The evaluation of light scattering measurements. H.-J. Cantow. Note in *Naturwissenschaften*, **41**, *No.* 15, 354–5 (1954) In German.

Describes two methods of obtaining the dependence of lateral scattering on wavelength and angle of incidence in the case of larger particles ($> \lambda/20$).

535.55

233. An optical investigation of the stress condition of an anisotropic plate subjected to a concentrated force. V. M. Krasnov and A. V. Stepanov. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1(7) 98–106 (1953) In Russian.

See also Abstr. 5739 (1953). Photoelastic methods were used to determine the stressed state in an anisotropic plate cut out from a single crystal of the 60 mol-% TlBr/40 mol-% TlI alloy, so that the plane of the plate coincided with the cube face, a concentrated force being applied along the cube axis. The apparatus used is described in some detail. A fair agreement was found to exist between experimental results and values calculated from the moduli of elasticity. F. LACHMAN

535.55

234. The dispersion of the double refraction of celluloid as a measure of plasticity in stress optics. E. Mönch. *Z. angew. Phys.*, **6**, *No.* 8, 371–5 (*Aug.*, 1954) In German.

A quantity $\bar{v}_0$, for which an expression is given in terms of tensile strain [A. Nadai, *Theory of flow and fracture of solids*, New York—Toronto—London (1950)] serves as a criterion for the degree of plastic deformation of a solid. The present article discusses the dispersion of celluloid and shows that this serves as a measure for $\bar{v}_0$. It is shown that by using two isochromatic figures for light of different wavelengths (5893 Å and 4358 Å) the quantity $\bar{v}_0$ can be found. Experimental graphs are given: celluloid, 8 mm thick, is used as the experimental material. H. G. JERRARD

535.7

Physiological optics. Vision. See under "Medical science. Human physiology." Decimal classification 612.84

535.8 : 771.35

235. Performance testing of photographic lenses. P. D. Carman and L. E. Howlett. Letter in *J. Opt. Soc. Amer.*, **44**, *No.* 9, 744 (*Sept.*, 1954).

The authors maintain that resolving power tests on photographic systems give good correlation with image quality, if resolution charts of the right contrast are used. No other method of specifying lens performance is as satisfactory and the attempt to find a single figure of merit for a lens is said to be quite illogical. R. W. FISH

535.81

236. The realization of an isoplanatic objective by apodization. R. N. R. Burtin. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 5, 408–9 (*Aug.* 2, 1954) In French.

Illustrates the use of an apodizing system formed by filling the space between a plane parallel window and a plano-convex lens with an absorbing liquid. R. W. FISH

535.81

237. Anodically produced multiple oxide films for increasing the reflectance of evaporated aluminum. G. Hass and A. P. Bradford. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 810–15 (*Oct.*, 1954).

Describes a method for preparing reflectance-increasing film pairs of Al_2O_3 and TiO_2 on evaporated aluminum mirrors. With one film pair of Al_2O_3 and TiO_2, each film effectively one-quarter wavelength thick, the visible reflectance of aluminum can be increased by 5%. To produce such a multilayer coating, TiO_2 is evaporated onto freshly deposited aluminum until the aluminum reflectance decreases to a minimum at $\lambda = 620$ mμ. The direct evaporation of TiO_2 results in a slightly reduced, strongly absorbing film material (TiO_x). By anodic treatment in an electrolyte, such as 3% ammonium tartrate, the absorbing TiO_x on aluminum can be oxidized to nonabsorbing TiO_2, and part of the aluminum can be converted to Al_2O_3 underneath the TiO_2. Seventy-five volts must be applied to produce quarter-wavelength thick films of Al_2O_3 and TiO_2 at $\lambda = 530$ mμ. $Al_2O_3 - TiO_2$ coatings furnish better protection than the most frequently used $MgF_2 - ZnS$ film pairs.

Two film pairs of Al_2O_3 and TiO_2 can also be applied in one anodic process. A.

535.822.9

238. An optical shadow-casting microscope. S. TOLANSKY. *Lab. Pract.*, **3**, *No.* 10, 405–9 (*Oct.*, 1954).

The heights of small objects can be measured from long shadows cast by illuminating at a grazing incidence less than 5°. It is essential that the objects should rest on a specially prepared surface which scatters light up into the microscope. The technique is described in detail and is used with shadow magnifications up to ×2500. The technique is extended to include features on crystal surfaces by producing the appropriate scattering surface *in situ* on the crystal. Examples from diamond, quartz and zinc crystals are illustrated. In addition to measuring surface structural features, local enhanced contrast of topographical features results. S. TOLANSKY

535.822.9 : 539.211

239. Application of the two-beam interference microscope to the study of surfaces. W. L. GRUBE AND S. R. ROUZE. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 851–60 (*Nov.*, 1954).

Interference microscopes that have recently become available have overcome many of the operational difficulties previously experienced. As a result, the two-beam interference microscope is finding increasing use in the laboratory in the study of surface topography. Present instruments are capable of examining surface detail in the range of 2 to 100 microinches peak-to-valley. A number of applications to the study of surfaces important in industry are presented. These include: (1) the measurement of thickness of electrodeposited coatings, (2) the study of the leveling properties of electrodeposits, (3) measurement of the erosion or shrinkage of paint films upon weathering, (4) investigation of hardness measurement indentations, (5) examination of industrial sheet-steel finishes, and (6) control of the geometry of accurate surface roughness standards. Replica techniques which make it possible to use the instrument to study curved and inaccessible surfaces are also discussed. A.

HEAT 536

536.2

240. Transient heat flow in anisotropic strata. D. R. SCOTT. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, *Pt* 9, 731 (*Sept.*, 1954).

The equation $K_x\frac{\partial^2 v}{\partial x^2} + K_y\frac{\partial^2 v}{\partial y^2} = \rho C\frac{\partial v}{\partial t}$ is transformed by the substitution $\bar{y} = y(K_x/K_y)^{\frac{1}{2}}$ into $\alpha_x\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial \bar{y}^2}\right) = \frac{\partial v}{\partial t}$ and the solution in cylindrical coordinates for an infinite line source, Q heat units per unit length per unit time, embedded in an infinite region exhibiting two-dimensional anisotropy is stated to be

$$V = B\int_{\phi}^{\infty}\frac{e^{-u}}{u}du \text{ where } B = Q/4\pi(K_xK_y)^{\frac{1}{2}},$$

$$\phi = (x^2 + \bar{y}^2)/4\alpha_x t,\ \alpha_x = K_x/\rho C$$

and K_x, K_y are the principal conductivities in the plane perpendicular to the line source. S. WEINTROUB

536.212.2 : 536.48

241. Thermal conductivity of phosphor bronze at liquid helium temperatures. R. A. CHENTSOV. *Zh. éksper. teor. Fiz.*, **27**, *No.* 1 (7) 126–8 (1954) In Russian.

A modification of Kohlrausch's method was used; the electrical resistance of a fine wire whose ends are in thermal contact with the bath was measured as a function of the current through it. The thermal conductivity was found to be approximately $(1{\cdot}1\times10^{-3})T^3$ in watt . cm^{-1} . deg^{-1} units down to 1·7° K, but the temperature dependence was rather slower below 1·7°K. D. SHOENBERG

536.422.15

242. The vapour pressure of calcium. I. P. E. DOUGLAS. *Proc. Phys. Soc.* [*London*] *B*, **67**, *Pt* 10, 783–6 (*Oct.*, 1954).

The vapour pressure in the temperature range 800°K–920°K has been measured by the Knudsen effusion method. Calcium metal was heated in a specially designed nickel crucible, and the vapour which effused through a narrow slit aperture into a well-defined solid angle was condensed and determined chemically. The vapour pressure p in mm Hg was found to be related to the absolute temperature T by the relation $\log_{10}p = 9{\cdot}59 - 10089/T$. A.

536.422.15

243. The vapour pressure of calcium. II. D. H. TOMLIN. *Proc. Phys. Soc.* [*London*] *B*, **67**, *Pt* 10, 787–94 (*Oct.*, 1954).

Further determinations of the vapour pressure of solid calcium have been carried out by a similar application of the Knudsen effusion method to that described by Douglas (preceding abstract), but with radiochemical analysis of the condensed deposits. It is concluded from the good agreement with the results of Douglas and of Pilling that vapour pressure data for the temperature range 800°K to 900°K are now well established, and that the results of Rudberg are in error. The matching of the results with those of Hartmann and Schneider for liquid calcium when extrapolation is made to the melting point is discussed. Agreement in this respect remains incomplete. A.

536.423.4

244. Time lag in the self-nucleation. H. WAKESHIMA. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1614–15 (*Sept.*, 1954).

An approximate, non-stationary solution of the Zeldovich–Frenkel nucleation equation is obtained, which satisfies different initial conditions from those postulated by Probstein [Abstr. 5354 (1951)]. The effective time-lag nevertheless turns out to be of the same order (10^{-6} sec) as that found by Probstein. It therefore fails to account for discrepancies which are known to occur with very rapid expansions in the supersonic flow of moist air. R. O. DAVIES

536.423.4

245. On the theory of condensation. A. J. F. SIEGERT. *Phys. Rev.*, **96**, *No.* 2, 243–9 (*Oct.* 15, 1954).

In an attempt to understand why approximations of the van der Waals type can yield semiquantitative results in spite of being qualitatively wrong, it has been assumed that the partition function for submacroscopic volumes, as a function of the number of

particles, is of the van der Waals type. As a model of a real fluid, a cubic array of submacroscopic cells with variable numbers of particles has been considered, and an interaction energy assumed between adjacent cells only. Since the van der Waals equation predicts two sharp peaks in the probability function for the occupation numbers, one has then essentially a three-dimensional Ising model. Using some of the known properties of the Ising model (and some which can be safely anticipated), with plausible assumptions about the interaction energy between cells, this model is found to exhibit condensation, and its condensation pressure, its isotherm in the stable states, and its critical temperature, to be still essentially determined by those of the individual cell. A.

536.423.4 : 533.7

246. On the theory of condensing systems. K. IKEDA. Letter in *Progr. theor. Phys.*, **11**, *No.* 3, 336–8 (*March*, 1954).

The author's modification of Mayer's theory is presented in the form of a concise summary. Its principal contribution concerns the method of finding the term in the partition function which may asymptotically replace the whole sum. Certain inaccuracies of the older theory, the author claims, are now avoided. R. EISENSCHITZ

536.424.1

247. On a new phase transition in the system Zn–Sb. H. BRUNS and G. LAUTZ. *Z. Naturforsch.*, **9a**, *No.* 7–8, 694–5 (*July–Aug.*, 1954) In German.

Measurements of the electrical properties of alloys with between 40 and 50 wt % Zn, in which the compounds Zn_3Sb_2 and Zn_4Sb_3 occur, show an anomaly at about −10°C. Below this temperature the resistivity is much higher than above, and from hysteresis effects in the transformation it is concluded that it is a real phase transition or an order–disorder transition in Zn_4Sb_3; X-ray work is proposed.

W. M. LOMER

536.432.15 : 532.13

Vapor pressure and viscosity of liquids. *See Abstr.* 96

536.44

248. The effect of gravitation on critical phenomena. H. D. BAEHR. *Z. Elektrochem.*, **58**, *No.* 6, 416–23 (1954) In German.

The empirical equation $\pi=1+0\cdot05(3\xi+1)(\xi-1)^3$, where π is the reduced pressure, and ξ the reduced density, describes the variation of the critical isotherm near the critical point. The calculated values agree within $\pm 0\cdot01\%$ with the available experimental data in the range $0\cdot82 < \xi < 1\cdot18$. The equation and the formulae derived from it enable the gravitation effects caused by the high compressibility of matter at the critical point to be evaluated. The significance of the effect of gravitation for the different theories of critical state is discussed. F. LACHMAN

536.44 : 541.265

249. A corrected Guldberg rule. S. T. BOWDEN. Letter in *Nature* [*London*] **174,** 613 (*Sept.* 25, 1954).

The relation $T_b\gamma^{\frac{1}{4}} = \frac{4}{3}T_c$ is found to be generally more accurate than $T_b = \frac{2}{3}T_c$. The parachor is shown to be given by $P = \frac{1}{2}V_cT_c/T_b$ which is in better agreement with experiment than existing similar relationships. W. GOOD

536.46

250. Acceleration of flames in the predetonation period. S. M. KOGARKO AND A. S. NOVIKOV. *Zh. éksper. teor. Fiz.*, **26**, *No.* 4, 492–503 (1954) In Russian.

Discussion paper. Measurements on hydrogen–oxygen mixtures containing various amounts of nitrogen show that acceleration of flames to detonative velocities in a homogeneous gas mixture is determined not only by normal flame speeds but also by movement of the gas as a whole, particularly if this is turbulent. This contradicts Sokolik's view [Abstr. 5738 (1952)] that predetonative acceleration of flames originates from the flame itself, and that only acceleration of the flame itself can contribute to reduction of the time before detonation sets in. R. C. MURRAY

536.461

251. Stability and structure of Bunsen flame. M. S. UBEROI. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1784 (*Oct.*, 1954).

A photograph is given to show how the tip of a lean propane–air flame established on a ¾-inch dia. tube changes from concave to convex inwards as the volume flow in the tube decreases. An explanation is suggested. W. GOOD

536.48

252. Vapour pressure of mixtures of He^3 and He^4. S. M. BHAGAT AND P. K. KATTI. *Sci. and Culture*, **20**, *No.* 1, 43–5 (*July*, 1954).

In evaluating the thermodynamical properties of liquid helium, by applying statistical mechanics to a potential well model, Heer and Daunt [Abstr. 4344 (1951)] neglect the difference between Gibbs' and Helmholtz' free energies. Making a theoretical estimate of this difference, authors find that the vapour pressure of a 20% mixture should, according to the model, be higher by more than 20% than the pressure calculated previously. R. EISENSCHITZ

536.48

253. Thermodynamics of the two fluid model of liquid helium II. J. W. HERIVEL. Letter in *Nature* [*London*] **174,** 322–3 (*Aug.* 14, 1954).

It is assumed that the normal component and the superfluid form a one-phase system in chemical equilibrium. In this case the energy of the liquid depends on the mass, volume and entropy of the mixture only and is independent of the contributions of the single components. This is shown by a simple thermodynamical argument in which the chemical potentials of the two components are assumed to be equal. In accordance with observation it follows that there is a range of pressures and temperatures in which the liquid mixture is in equilibrium with the vapour phase, whereas a two-phase model of the liquid would restrict the range to a triple point. The thermo-mechanical effect is derived by assuming equality of the chemical potential of the superliquid in two portions of liquid having different pressures and temperatures; the familiar formula for $\Delta p/\Delta T$ is obtained. R. EISENSCHITZ

536.48

254. The thickness of the saturated helium film above and below the λ-point. A. C. HAM AND L. C. JACKSON. Letter in *Phil. Mag.*, **45**, 1084–7 (*Oct.*, 1954).

The optical measurements are evaluated on the

assumption that the refractive indices of bulk liquid and film are equal; otherwise no hypothetical assumptions are involved and systematic errors are carefully eliminated. Thickness of static films is measured optically for heights between 0·4 and 1·6 cm and at temperatures between 1·2 and 3·8°K. At the λ-point and a height of 1 cm the thickness is found to be $2{\cdot}85\times10^{-6}$ cm; this thickness persists at higher temperatures and increases slightly at lower temperatures. In the presence of a thin layer of solid air and below the λ-point the thickness is greatly increased. R. EISENSCHITZ

536.48

255. λ transition of liquid helium. R. KIKUCHI. *Phys. Rev.*, **96**, *No.* 3, 563–8 (*Nov.* 1, 1954).

The partition function of liquid helium proposed by Feynman, $q = \Sigma g(L)\exp(-aTL)$, is calculated for a simple cubic lattice using an approximation corresponding to Bethe's method for the Ising model. It is shown that a second-order transition occurs at $aT_\lambda = \ln 4$, or $T_\lambda = 2{\cdot}9m/m'$ °K (m and m' representing the true and the effective masses of a helium atom). The nature of the approximation is discussed. A.

536.48

256. Further considerations regarding liquid helium II at high pressures. Z. MIKURA. Letter in *Progr. theor. Phys.*, **11**, *No.* 4–5, 503–4 (*April–May*, 1954).

The author's model of liquid helium [Abstr. 8233 (1954)] is used for calculating the torque in the Rayleigh-disk experiment. Results for pure He^4 are presented in the form of isobaric torque/temperature curves corresponding to pressures from 5 to 25 atm. See also abstract following. R. EISENSCHITZ

536.48

257. On the thermal Rayleigh disk in liquid helium containing He^3. Z. MIKURA. Letter in *Progr. theor. Phys.*, **11**, *No.* 4–5, 504–5 (*April–May*, 1954).

Calculations (preceding abstract) are extended to solutions of He^3 in He^4. Results are given in form of torque–temperature curves for concentrations of 0·8–4%. In the diagram one experimental point is shown; it is compatible with calculations. R. EISENSCHITZ

536.531 : 551.508.1

Thin-wire thermometer for radiosondes. *See Abstr.* 647

536.532

258. Calibration of a nickel–molybdenum thermocouple. R. D. POTTER. *J. appl. Phys.*, **25**, *No.* 11, 1383–4 (*Nov.*, 1954).

A report is made of a calibration up to 2242°F (50 mV). A.

536.55 : 534.22

Ultrasonic temperature measurement in internal combustion engine chamber. *See Abstr.* 131

536.626

259. New design of a vacuum jacket precision combustion calorimeter. P. B. AITKEN, H. L. BOXALL AND L. G. COOK. *Rev. sci. Instrum.*, **25**, *No.* 10, 967–70 (*Oct.*, 1954).

The calorimeter is rugged, reliable, and easy to disassemble and assemble. The heat leakage is lower by a factor of six than in the air gap types which have been standard since 1915. The calorimeter appears to be capable of giving individual results which deviate not more than 1·5 parts in 10 000 from the mean. A.

536.632

260. Measurement of the specific heats of poor thermal conductors using the E. Calvet differential microcalorimeter. J. BROUTY AND E. CALVET. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 11, 672–4 (*Sept.* 13, 1954) In French.

See Abstr. 9211 (1954). Considers the effect of "thermal disequilibrium" due to poor thermal conductivity which is negligible in the case of good conductors but may be important in other cases. F. E. HOARE

536.654/.655

261. On the heats of sublimation and evaporation of germanium. R. E. HONIG. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1610 (*Sept.*, 1954).

Tabulates the results obtained for the heat of sublimation of Ge_1 and for the heats of evaporation of Ge_1, Ge_2, Ge_3 and Ge_4, using a mass spectrometer described by the author in *Analyt. Chem.*, **25**, 1530 (1953). These results show a reasonable agreement with those obtained by Searcy, and Lehovac *et al* [Abstr. 3238, 5439 (1953)]. The appearance potentials measured for the ions Ge_1^+, Ge_2^+ and Ge_3^+ point to the fact that Ge_2^+ and Ge_3^+ are mainly parent ions derived from Ge_2 and Ge_3, respectively, and not fragment ions of larger molecules. F. LACHMAN

536.654

262. Sublimation studies of silicon in the mass spectrometer. R. E. HONIG. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1610–11 (*Sept.*, 1954).

Tabulates the heats of sublimation (L_{1550}) determined for the four most prominent species of Si (from one to four atoms per cluster) in a 180° mass spectrometer; it follows from the values obtained for Si_1 and Si_2 that the dissociation energy of the Si_2 molecule is 75 kcal/mole. A graph provides a comparison between the vapour pressure data obtained by the author and those of Ruff and Konschak [*Z. Elektrochem.* **32**, 68 (1926)], Baur and Brunner [*Helvetica chimica Acta*, **17**, 958 (1934)] and Brewer [paper 3 in *The chemistry and metallurgy of miscellaneous materials: thermodynamics*, L. E. Quill, editor, New York (1950)]. F. LACHMAN

THERMODYNAMICS 536.7/.8

536.7

263. Thermodynamics of alcohol–hydrocarbon mixtures. C. B. KRETSCHMER AND R. WIEBE. *J. chem. Phys.*, **22**, No. 10, 1697–701 (*Oct.*, 1954).

The thermodynamic properties of alcohol-hydrocarbon mixtures are explained on the basis of association of the alcohol to form polymers of all orders from two to infinity. The treatment differs from that of Redlich and Kister in using the Flory–Huggins expression for free energy, and an equilibrium constant in terms of concentrations rather than mole

fractions. The equations derived are in satisfactory agreement with vapour-pressure data for several systems. They also agree with the experimental energy of mixing and excess entropy for ethanol–methylcyclohexane solutions. For mixtures of alcohols with aromatic hydrocarbons, it is necessary to assume that each alcohol monomer or polymer can combine with one molecule of hydrocarbon. A.

536.7 : 530.162

Fundamental problem of statistical mechanics. *See Abstr.* 76

536.7 : 533.7

264. Note on the partition function of a free rotator. T. TANAKA. *J. Phys. Soc. Japan*, **9**, *No.* 4, 472–4 (*July–Aug.*, 1954).

An integral representation of the density matrix of a free rotator is obtained by the use of the Fourier transformation. The general term of the high-temperature expansion for the partition function is also obtained. A.

536.7 : 533.7

A proposal for fundamental equations of dynamics of gases under high stress. *See Abstr.* 119

536.7 : 539.31

265. Thermodynamical extension of the theory of after-effects [viscoelasticity]. J. MEIXNER. *Z. Phys.*, **139**, *No.* 1, 30–43 (1954) In German.

The laws for the elastic after-effects, including those of entropy- and temperature after-effects, are formulated within the range of validity of Boltzmann's principle of superposition. The extension leads to a characterization of the effects by a 7×7 matrix whose symmetry is proved by a generalization of Onsager's principle of reciprocity. The elastic matrix obtained by a Laplace transformation has a positive quadratic form when regarded as a function of $p = i\omega$ (ω = ang. freq.). From this follows a close analogy between 2-pole electric networks and the phenomena of after-effects, with the possibility of representing the latter by the former. Finally it is shown how relaxation theory and the so-called dynamical eqns. of state can be incorporated in the general thermodynamical theory. F. ANSBACHER

536.7 : 541.183

Thermodynamics of adsorption. *See Abstr.* 609

536.71

266. Equation of state of argon. R. H. CHRISTIAN AND R. G. SHREFFLER. Letter in *J. appl. Phys.*, **25**, *No.* 10, 1341–2 (*Oct.*, 1954).

A Hugoniot diagram of argon, obtained by using improved techniques, is given, and is found to agree well with the graph calculated by Wood using standard methods of statistical mechanics [Abstr. 4282 (1954)]. J. S. G. THOMAS

536.75

267. On the entropies of complex ions in aqueous solution. P. GEORGE, G. I. H. HANANIA AND D. H. IRVINE. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1616 (*Sept.*, 1954).

A formula is suggested for the empirical calculation of standard partial molar entropies of oxy-anions and complex ions: $\overline{S_0} = A - BZ + CN$. A, B and C are constants, N is the total number of ligands. The constants are calculated for various molecules and discussed. A. J. TAYLOR

536.75

268. Principle of minimum entropy production. M. J. KLEIN AND P. H. E. MEIJER. *Phys. Rev.*, **96**, *No.* 2, 250–5 (*Oct.* 15, 1954).

The principle of minimum entropy production says that the steady state of an irreversible process, i.e. the state in which the thermodynamic variables are independent of the time, is characterized by a minimum value of the rate of entropy production. This theorem, due to Prigogine, is proved by the methods of statistical mechanics for a particular process—the flow of matter and energy through a narrow tube connecting two containers of an ideal gas. The two containers are maintained at slightly different temperatures. The resultant form for the entropy production in the steady state, and the method used in the proof, give additional insight into the significance of the principle of minimum entropy production. A.

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.221

269. Electrical charging in turbulent dust clouds. E. BODENSTEDT. *Z. angew. Phys.*, **6**, *No.* 7, 297–303 (*July*, 1954) In German.

Describes a method for measuring the quantity and sign of charge associated with different types of dust of various particle sizes. Statistical analysis shows that the danger of self-excited dust explosions is greatest with dust of small particle size. J. H. MASON

537.226

270. Energetic relations in a space-dispersive medium. M. E. GERTSENSHTEĬN. *Zh. éksper. teor. Fiz.*, **26**, *No.* 6, 680–3 (1954) In Russian.

In a medium in which the charged particles are not at rest, the dielectric constant ε can be a function of the propagation vector $\boldsymbol{k}$ of the electromagnetic wave. For this case, various invariants are constructed and it is shown that energy is propagated with the group velocity of the waves. G. E. BROWN

537.226

271. The electron atmosphere in dielectrics. M. J. MORANT. Letter in *J. appl. Phys.*, **25**, *No.* 8, 1053–4 (*Aug.*, 1954).

Errors in a paper by Skinner *et al.* [Abstr. 4433 (1953)] are pointed out. The use of Fermi level diagrams, and the assumption of narrow air gaps is queried, and the possibility that the low conductivity of amorphous dielectrics is due to a low carrier mobility rather than a low number of carriers is raised. W. M. LOMER

537.226

272. Electrical phenomena in adhesion. I. Electron atmospheres in dielectrics. D C. WEST. Letter in *J. appl. Phys.*, **25**, *No.* 8, 1054–5 (*Aug.*, 1954).

Errors in a paper by Skinner *et al.* [Abstr. 4433

(1953)] are pointed out. There is a false assumption of zero surface charge at the interface of two dielectrics, and a related criticism of the conditions at the centre of one of the dielectrics. Other solutions of the fundamental equations are pointed out and the physical situations they describe are discussed.

W. M. LOMER

537.226

273. Electrical phenomena in adhesion: further comments on electron atmospheres. S. M. SKINNER, R. L. SAVAGE AND J. E. RUTZLER, JR. Letter in *J. appl. Phys.*, **25,** *No.* 8, 1055–6 (*Aug.*, 1954).

A reply to criticisms [see preceding two abstracts]. Certain errors arising from the use of solutions for an infinitely thick layer are shown to be negligible, but other errors are agreed to change the calculated charge distribution. A detailed justification of the Fermi level arguments is given, the significance of the large energy gap in insulating adhesives is explained, and the relation of adhesion to properties of both metal and adhesive discussed. It is not considered permissible to attribute the low conductivity of the adhesive to a low mobility; it is due to a low carrier density. W. M. LOMER

537.226.1.08

274. A new method for measuring the complex permittivity of [low or medium loss] liquids at u.h.f. C. BROT. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 9, 612–13 (*Aug.* 30, 1954) In French.

It is shown theoretically that standing-wave measurements on liquid samples in short-circuit terminated waveguides are more sensitive to variation in the dielectric loss of the sample than methods using open-circuit terminated guides [Abstr. 3331 (1948)].

J. H. MASON

537.226.2/.3 : 539.32 : 621.3.011.5 : 621.315.616.9

275. The dynamic mechanical and electrical behavior of polymethyl methacrylate. D. TELFAIR. Letter in *J. appl. Phys.*, **25,** 1062–3 (*Aug.*, 1954).

Graphs show the variation with temperature, between 30° and 130°C, of the permittivity, loss angle, dynamic shear modulus, and mechanical damping capacity. The activation energy calculated from the electrical data does not agree with a value estimated from data of Alexandrov and Lazurken [*Acta Physicochimica* (*USSR*) **12,** 647 (1940)] [The graphs in Figs. 2 and 3 have been interposed]. J. H. MASON

537.226.2

276. The dielectric behaviour of acetaldehyde vapour at 9000 Mc/sec. KRISHNAJI AND P. SWARUP. *Z. Phys.*, **138,** *No.* 5, 550–6 (1954).

The complex dielectric constant of the acetaldehyde vapour and its dependence on pressure and temperature has been studied. The electric susceptibility is found to vary linearly with pressure in the moderate pressure region. The absorption coefficient varies approximately as p^2, showing convexity towards pressure axis. The temperature-dependence law as obtained by absorption coefficient measurements at temperatures between $-8°$ to 50°C follows T^{-3} law as expected on Anderson's or Margenau's expressions for $\overline{\Delta\nu}$. A.

537.226.2

277. Dielectric properties of tellurite glasses. J. P. POLEY. Letter in *Nature* [*London*] **174,** 268 (*Aug.* 7, 1954).

Precision measurements from 0·07–24 000 Mc/s show that ε' drops only 2% (26·0 to 25·5) over the whole range and $\tan\delta$ remains small ($\sim$0·002). There is therefore no relaxation up to 24 000 Mc/s and the tellurite glass has good microwave properties.

R. O. DAVIES

537.226.2 : 537.226.31

278. Dielectric properties of wool-water systems at 3000 and 9300 megacycles. J. J. WINDLE AND T. M. SHAW. *J. chem. Phys.*, **22,** *No.* 10, 1752–7 (*Oct.*, 1954).

The dielectric constant ε' and dielectric loss ε'' for wool-water systems have been determined at frequencies of 3000 and 9300 Mc/s by a cavity resonator method. The water content of the wool fibres was varied between 0 and 14% of the weight of the dry wool. The upper limit of 14% is approximately one-half the amount of water wool will absorb in a saturated atmosphere at 25°C. The increased dielectric loss in the systems studied and the resultant attenuation of microwave power prevented measurements from being made at water contents in excess of approximately 14%. The results of the measurements show that both ε' and ε'' increase with increasing water content. The results have been analysed in terms of a sorption theory proposed by Cassie which shows that the water sorbed by wool consists of localized water which is intimately bound to polar sites in the wool and mobile water which constitutes the remainder sorbed. The dielectric constant of the localized water is found to be 5·8 at both frequencies. This result compares favourably with the microwave dielectric constant of irrotationally bound water obtained by Buchanan *et al.* from studies of protein hydration. It has been found that ε' and ε'' of the mobile water are less than for liquid water if the dielectric properties of the wool are assumed to be unaffected by water sorption. The alternate assumption (in which ε' and ε'' for the mobile water are set equal to those of liquid water) is discussed. A.

537.226.2

279. Dielectric constant and loss measurements on barium titanate single crystals while traversing the hysteresis loop. M. E. DROUGARD, H. L. FUNK AND D. R. YOUNG. *J. appl. Phys.*, **25,** *No.* 9, 1166–9 (*Sept.*, 1954).

A small amplitude high-frequency voltage has been superposed on a large amplitude low-frequency sweeping voltage to study the dielectric behaviour of barium titanate single crystals while traversing the hysteresis loop. The output of a capacitance bridge (filtered to pass only the high-frequency component) is displayed on an oscilloscope as a function of either the applied sweeping voltage, the polarization, or the current to the sample. As a result, the bridge can be balanced for any portion of the sweeping voltage cycle desired. The dielectric constant and loss obtained in this manner have been studied as a function of measuring frequency, of sweeping frequency, of sweeping voltage and of rate of switching polarization (current). The

measuring frequency and the switching current are shown to be the significant variables. The frequency dependence of the dielectric constant and loss can be described by a relaxation type of spectrum with a relaxation time of 5·5 μsec. A.

537.226.2 : 621.315.612.4

280. A study of the dependence of the dielectric permittivity of barium titanate on the duration of the action of the potential. F. S. Zavel'skiĭ. *Zh. éksper teor. Fiz.*, **25**, *No.* 4 (10) 479–85 (1953) In Russian.

The permittivity ε of a barium titanate capacitor was studied as a function of the strength and duration of an applied voltage. In the range up to 10 kc/s (field strengths 10–25 kV/cm) a capacity bridge was used. At higher frequencies an impulse generator was used to prevent the heating up of the sample, and results for impulses of $t = 5\times10^{-8}$ to 5×10^{-5} sec and fields $E = 5$–15 kV/cm show that ε varies non-linearly with t from ~1300 to ~2500 and that the increase of E increases ε by some 500 units. This behaviour can be understood qualitatively in terms of a spontaneous polarization within the domains of the sample. W. J. SWIATECKI

537.228.1

281. Re-examination of low-temperature properties of crystalline quartz. A. Pavlovic and R. Pepinsky. *J. appl. Phys.*, **25**, *No.* 10, 1344–5 (*Oct.*, 1954).

The electrical resonance of α-quartz is shown to continue to temperatures below 91°K, contrary to the results of Osterberg [*Phys. Rev.*, **49**, 552 (1936)]. X-ray diffraction and dielectric constant measurements indicate no $\alpha \rightarrow \delta$ transition between 846° and 4·2°K. P. CUCKA

537.228.4

282. The theory of the Kerr effect in nonpolar liquids. G. Klages. *Z. Naturforsch.*, **9a**, *No.* 7–8, 602–7 (*July–Aug.*, 1954) In German.

The Kerr constant for nonpolar liquids is derived theoretically by assuming that a nonpolar molecule is equivalent to an ellipsoid of homogeneous dielectric, whose principal refractive index n_{M_i} lies along the main axis of the ellipse. The significance of this theory and particularly of the quantity n_{M_i} is discussed in relation to experimental measurements in pure nonpolar liquids and in liquid mixtures. J. H. MASON

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3.08 : 621.317.351

283. Wide-band amplitude distribution analysis of voltage sources. L. W. Orr. *Rev. sci. Instrum.*, **25**, *No.* 9, 894–8 (*Sept.*, 1954).

A method is described which employs two commercial oscilloscopes and a phototube. The minimum set-up can be assembled quickly in the laboratory from standard equipment, and gives a rapid analysis accurate to better than 5%. It is free from the severe band-width restrictions of other methods, and can often be employed up to 500 Mc/s. Results on two noise sources are included for illustration, and a modification for improving the resolution and increasing the accuracy is presented. A.

537.311.1 : 621.38

284. Experimental study of the thermal noise of some conductors. V. S. Troitskiĭ, A. G. Lyubina and A. V. Zolotov. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4 (10) 455–62 (1953) In Russian.

The formula for the spectral noise density $w = 4kRT$, where k = Boltzmann's constant, R = resistance, T = abs. temperature of the specimen, was verified to ½% at frequencies 52, 200, 3000 kc/s for chrome nickel, 1% KCl solution, Cu, Mn, Constantan, W, Ag, Ni, Mo, Fe and graphite in the temperature range $T = 300$–700°K and $R = 50$–1200 Ω. The effect of annealing chrome nickel in a cycle through 500°C was found to have no effect on w. [Contrast the results of E. Ya. Pumper, e.g. Abstr. 6207 (1951)]. The instrument used was a null fluctuation meter [see Abstr. 4346 (1952), where a summary of the results is also given]. W. J. SWIATECKI

537.311.31

285. Electrical resistance minimum in dilute copper alloys. W. B. Pearson. Letter in *Phil. Mag.*, **45**, 1087–9 (*Oct.*, 1954).

Experimental evidence suggests that the observed resistance minima are due to the distribution of impurity atoms along grain boundaries. E. P. WOHLFARTH

537.311.31 : 621.317.331

286. Measurement of the electrical resistance of metals and alloys at high temperatures. P. Chiotti. *Rev. sci. Instrum.*, **25**, *No.* 9, 876–83 (*Sept.*, 1954).

An alternating current potentiometric method is described. The potential developed between two probes which make contact with the test piece is balanced against a potential developed across the secondary of a current transformer. The primary of the current transformer is connected in series with the test piece. The test piece in the form of a bar is mounted between water-cooled copper electrodes and is heated by passing a high 60-cycle current through it. The resistance is measured directly. A furnace and automatic recording and control instruments which can be used in conjunction with this method are described. A.

537.311.33

287. A photoelectric method, for simultaneous measurement of life-time and mobility of injected charge carriers in semiconductors. G. Adam. *Z. Naturforsch.*, **9a**, *No.* 7–8, 607–11 (*July–Aug.*, 1954) In German.

By using modulated light a uniform density of additional charge carriers is produced in germanium. The unsymmetrical stationary charge distribution produced in the irradiated region gives a proportional photovoltage at a point probe which is presented on an oscilloscope. The distribution is calculated and life times and diffusion constants determined from measurements with the probe. Results are obtained for specimens of germanium doped in different ways. G. F. J. GARLICK

537.311.33

288. On the determination of the optical constants of semiconductors of type $A^{III}B^{V}$ in the infrared. F. Oswald and R. Schade. *Z. Naturforsch.*, **9a**, *No.* 7–8, 611–17 (*July–Aug.*, 1954) In German.

The absorption constants and refractive indices are measured in the 0·8–15·2 μ region for the compounds AlSb, GaSb, InP, InAs, InSb and for Ge and the width of the respective forbidden energy zones estimated. G. F. J. GARLICK

537.311.33

289. Theory of the effect of spin-orbit coupling on magnetic resonance in some semiconductors. R. J. Elliott. *Phys. Rev.*, **96**, *No.* 2, 266–79 (*Oct.* 15, 1954).

The effect of spin-orbit coupling on the usual band theory of electrons in a lattice is considered. Particular attention is given to the bands in impurity semiconductors with diamond-type structure. g-values are calculated for electron states typical of various possible cases and it is found that different values are obtained according as to whether the Fermi level is near or distant from a band degeneracy. The spin-lattice relaxation time is calculated so that the effect of spin-orbit coupling on the wave-functions is included, and times in fair agreement with those observed in silicon and alkali metals are obtained. A.

537.311.33 : 537.323

290. Theory of thermoelectric power in semiconductors. J. Tauc. *Phys. Rev.*, **95**, *No.* 6, 1394 (*Sept.* 15, 1954).

An error occurring in a paper by Johnson and Lark–Horowitz [Abstr. 1307 (1954)] is corrected by calculating the thermoelectric power directly from the electrical current density expression. A general equation for the thermoelectric power is given which holds for semiconductors with one or two kinds of current carriers in thermal equilibrium governed by classical or Fermi–Dirac statistics. A.

537.311.33

291. The interpretation of the properties of indium antimonide. T. S. Moss. *Proc. Phys. Soc.* [*London*] *B*, **67**, *Pt* 10, 775–82 (*Oct.*, 1954).

The data given on the optical properties of InSb [Abstr. 300 (1955)] are analysed and precise values for the position and temperature dependence of the absorption edge are given. The variation of the position of the absorption edge with impurity concentration is explained by the very low effective mass of the conduction electrons, which is estimated by three methods to be about 0·03 of the free electron mass. A.

537.311.33

292. Effect of oxygen on the electrical properties of lead telluride films. D. E. Bode and H. Levinstein. *Phys. Rev.*, **96**, *No.* 2, 259–65 (*Oct.* 15, 1954).

The effect of oxygen on the electrical properties of PbTe films has been investigated. Oxygen, which presumably is adsorbed on the surface of the film, causes an increase in film resistance, followed by a decrease in resistance with increasing exposure to oxygen. The film which is originally "n" type changes to "p" type in the vicinity of the resistance maximum. The magnitude of the photoresistive and photovoltaic effect varies with the amount of oxygen adsorbed by the film. A model has been presented whereby oxygen removes electrons first from the conduction band, then from trapping states, and finally from the valence band, thereby producing the observed effects. A.

537.311.33

293. On the theory of rectification at the metal-semiconductor contact. W. Schultz. *Z. Phys.*, **138**, *No.* 5, 598–612 (1954) In German.

It is shown for semiconductors with high mobility values and long diffusion lengths for minority carriers, that at the metal-semiconductor contact the electron current can be calculated from diode theory and the hole current from the theory of p–n junctions. Expressions for the barrier capacity are derived. C. A. HOGARTH

537.311.33

294. On apparent-conductivity measurements on indium–germanium alloy rectifiers. H. L. Rath. Note in *Z. Naturforsch.*, **9a**, *No.* 7–8, 699–700 (*July–Aug.*, 1954) In German.

537.311.33

295. Transient response of a p–n junction. B. Lax and S. F. Neustadter. *J. appl. Phys.*, **25**, *No.* 9, 1148–54 (*Sept.*, 1954).

This is investigated in a circuit where the applied voltage is suddenly switched from the forward to the reversed direction. The behaviour is studied as a function of the circuit resistance. The solution of the appropriate diffusion equation is carried out for a time-dependent boundary condition, resulting in an integrodifferential equation. Analytical and numerical results for the current and the junction voltage as a function of time are then obtained by suitable approximations for the "recovery" and reverse periods. The "recovery" or reversal time t_f is the time required for the junction voltage to become negative and is given by $\operatorname{erf}\sqrt{(t_f/\tau)} = 1/\{1 + (If/Ir)\}$ where τ is the lifetime of holes, I_f is the forward current, and I_r the initial reverse current, which is limited by the external resistance. A.

537.311.33

296. Flow of electrons and holes through the surface barrier region in point contact rectification. M. Cutler. *Phys. Rev.*, **96**, *No.* 2, 255–9 (*Oct.* 15, 1954).

Equations are derived for the flow of electrons and holes through a surface barrier region by using the emission theory. The solution allows for non-equilibrium concentration of carriers on the semiconductor side of the barrier. It also allows for the possibility that part of the applied potential is between the metal surface and the semiconductor surface, as would occur if the surface states do not remain in equilibrium with the metal. The solution for the rectification characteristic is completed for the special case of small currents by combining the barrier region equations with the solution for current flow beyond the barrier region. The resulting equations are compared with those for p–n junctions, and the implications are discussed with regard to the relative roles of diffusion and emission in the flow of electrons and holes. Finally, the small current equations are

compared with experiment, with a discussion of the evidence for the existence of an inter-surface potential. A.

537.312.5

297. Photoconductive and photovoltaic thallous sulphide layers. A. Wolska. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 5, 179–84 (1953).

Describes the production of sensitive layers *in vacuo* starting with $Tl_2S_2O_3$. Properties of typical layers are reported. C. A. HOGARTH

537.312.5

298. On the physical properties of the antimony-caesium cathode. N. M. Politova. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4 (10) 463–70 (1953) In Russian.

A study of the energy spectrum of photoelectrons from Sb–Cs cathodes of thickness 10^{-5}, 10^{-6}, 10^{-7} cm irradiated with light of $\lambda = 4780$, 5380, 5980 Å, as deduced from "stopping curves" of emission current *v.* opposing voltage. It is deduced that the photo-emission takes place in a layer $\sim 10^{-5}$–10^{-6} cm thick, and that energy losses during passage out of the cathode play an important role. For a thickness $< 10^{-6}$ cm emission from the backing metal is observed. The influence of the backing material was studied by comparing results for Al and glass backings. Measurements showed that the thermoelectric work function of Sb–Cs cathodes, calculated by the method of contact potential differences, is not equal to the photoelectric work function and depends, in contrast to the latter, on the thickness of the Sb–Cs layer and on the backing material. The study of stopping curves for secondary electrons shows that also for Sb–Cs cathodes there appears a group of electrons whose emergence from the cathode requires accelerating voltages many times the difference of contact potential between cathode and anode. W. J. SWIATECKI

537.312.5

299. Determination of trap distribution by modulated light measurements on single crystals of photo-conducting cadmium sulphide. E. A. Niekisch. Note in *Z. Naturforsch.*, **9a**, *No.* 7–8, 700–1 (*July–Aug.*, 1954) In German.

The effective mobility of conduction electrons depends on the trapping states, and measurements of this with weakly modulated periodic excitation provide a means of determining the trap distribution. [See also Abstr. 4984 (1950)]. G. F. J. GARLICK

537.312.5 : 535.323

300. Optical and photo-electrical properties of indium antimonide. D. G. Avery, D. W. Goodwin, W. D. Lawson and T. S. Moss. *Proc. Phys. Soc. [London] B*, **67**, *Pt* 10, 761–7 (*Oct.*, 1954).

Measurements have been made of the refractive index and absorption index of InSb by reflection methods with polarized radiation. Extensive studies of absorption constant have been made by direct transmission measurements. Both photovoltaic and photoconductive effects have been observed in InSb. At room temperature the photosensitivity extends to approximately $7{\cdot}5\,\mu$, a considerably longer wavelength than for any other known material. A.

537.312.5 : 539.11

301. The photo-effect in thin metal films. D. J. Fourie. Note in *Naturwissenschaften*, **41**, *No.* 14, 328–9 (1954) In German.

The photoelectric emission from thin films of Cd, Te and Bi, evaporated on to glass, and of sputtered Sn is measured. The results are discussed in terms of the energy bands of the materials. C. A. HOGARTH

537.312.62

302. On the question of the superconductivity of Bi_2Pd. N. E. Alekseevskiĭ, N. N. Zhuravlev and I. I. Lifanov. *Zh. éksper. teor. Fiz.*, **27**, *No.* 1(7) 125–6 (1954) In Russian.

The α modification of Bi_2Pd (monoclinic) obtained by quenching has a superconducting transition at $1{\cdot}70°$K and the β modification (tetragonal) obtained by annealing, at $4{\cdot}25°$K. A smeared-out transition between these temperatures is obtained if both phases are present [see also Abstr. 5481 (1953)]. D. SHOENBERG

537.312.62

303. Superconductivity of vanadium at 24 000 Mc/sec. C. J. Grebenkemper. *Phys. Rev.*, **96**, *No.* 2, 316–18 (*Oct.* 15, 1954).

The high-frequency resistance of vanadium was measured at frequencies in the vicinity of 24 000 Mc/s in both the normal and superconducting states using resonant cavity techniques. The normal conductivity was not affected by the "anomalous skin effect" as much as the "soft superconductors." The inner surfaces of the cavities were mechanically polished to a good surface finish. The normalized surface resistance extrapolated to absolute zero yields a value of $0{\cdot}007$ times its initial resistance. A.

537.312.62 : 538.24

Magnetization of tin at the superconducting transition. *See Abstr.* 391

537.312.62 : 539.32

Elastic moduli of tin at the superconducting transition. *See Abstr.* 571

537.322

304. The contribution of phonons to the Thomson coefficient. P. G. Klemens. Note in *Austral. J. Phys.*, **7**, *No.* 3, 520–2 (*Sept.*, 1954).

The contribution μ_P is estimated analytically. For semiconductors μ_P may be appreciable and in general is proportional to the lattice thermal conductivity. C. A. HOGARTH

537.323 : 539.389.2

305. Thermoelectric power and the Bauschinger effect. R. L. Woolley. Letter in *Nature* [*London*] **174**, 566–7 (*Sept.* 18, 1954).

It is suggested, and verified experimentally for copper, that thermoelectric power should remain approximately constant during Bauschinger straining (a reversal of stress after plastic deformation). See also Abstr. 1139 (1952); 7995 (1953). E. P. WOHLFARTH

537.324

306. On particular thermoelectric assemblies. M. Perrot and G. Peri. Letter in *C.R. Acad. Sci. [Paris]* **239**, *No.* 7, 537–9 (*Aug.* 18, 1954) In French.

Measurements of the thermoelectric effect of Al_2O_3 compressed between metal electrodes are reported. When damp, polarization effects are found. C. A. HOGARTH

ELECTRIC DISCHARGES 537.52

537.523.4

307. Non-isothermal plasmas in the rare gases. R. D. Craig and J. D. Craggs. Letter in *Nature* [*London*] **174,** 367–8 (*Aug.* 21, 1954).

A short note reporting preliminary experiments in neon from which it appears that 1 μsec constant current (110 A) pulses at 1 atm pressure do not give appreciable gas heating, so that the afterglow conditions are not complicated by thermal excitation and ionization. J. D. CRAGGS

537.525.3 : 537.525.72 : 537.525.8

308. Electrode separation as a determinant of the optimum pressure for maximum negative Joshi effect. S. R. Mohanty, G. V. G. Krishna Rao and J. Jayaraman. Letter in *J. sci. industr. Res.*, **13B,** *No.* 8, 583 (*Aug.*, 1954).

Briefly describes further measurements on ozonizer tube discharges in pure oxygen. J. D. CRAGGS

537.525.3 : 537.525.72 : 537.525.8

309. A note on the "threshold potential" of ozonizer discharge and its dependence on electrode surface. N. A. Ramaiah. Letter in *J. sci. industr. Res.*, **13B,** *No.* 8, 583–4 (*Aug.*, 1954).

Discusses the influence of surface films on the walls of ozonizer tubes, showing the Joshi effect, in the initiation of the discharge. J. D. CRAGGS

537.525.5

310. Current limitation in the low-pressure mercury arc. J. E. Allen and P. C. Thonemann. *Proc. Phys. Soc.* [*London*] *B,* **67,** *Pt* 10, 768–74 (*Oct.*, 1954).

Measurements on current limitation in the low-pressure mercury arc are reported and a theory is given which depends on the limit to the ion generation set by the flux of neutral atoms passing from the walls into the plasma. The paper refers to low current discharges, where self-magnetic field effects are negligible. A.

537.525.8

311. Occurrence of positive and negative Joshi effects in Geiger and self-maintained regions of low frequency electric discharge in iodine vapour: influence of temperature. N. Subrahmanyam and N. A. Ramaiah. *J. sci. Res. Banaras Hindu Univ.*, **4,** 1–19 (1953–54; publ. *July*, 1954).

Cathode ray oscillographic studies of iodine vapour discharge by low frequency a.c. potentials indicated the production of appreciable positive Joshi effect ($+\Delta i$) in the Geiger or parasitic region and negative effect ($-\Delta i$) in the self-maintained region of the discharge. Under constant density conditions, increase of temperature (T) of the system lowered the upper limit, leading to a decrease in the width, of the Geiger region; this suggested that the secondary processes responsible for the maintenance of the discharge, chiefly those concerned with the liberation of electrons from the cathode (C), were facilitated presumably by elimination at large T of adsorbed iodine layers and therefore, a decrease in the work function ϕ of the cathode. Suggestively enough, the conductivity at a fixed applied field in the self-maintained regime increased with T as a result of low ϕ and therefore enhanced secondary emission from C. Further, the positive effect $+\Delta i$, which, according to Joshi, was due to uncaptured electrons (and their secondaries) released under light from the boundary layer on the cathode, was also favoured by T. In agreement with earlier results of Joshi, the negative effect $-\Delta i$ was inhibited by, and could not be noticed at, large T. The differential behaviour of positive and negative effects with temperature pointed out their distinctive character, especially in the nature of their origin. A.

537.525.8

312. Surface dependence of Joshi effect and adsorption. N. Subrahmanyam, M. G. Bhatawdekar and N. A. Ramaiah. *J. sci. Res. Banaras Hindu Univ.*, **4,** 20–41 (1953–54; publ. *July*, 1954).

Earlier work on the Joshi effect Δi has elucidated the preferential dependence of Δi on electrode surface, rather than the homogeneous gas phase. In accord with this was the suggestion due to Joshi that an adsorption-like layer formed under discharge was the chief seat of Δi. The significance of the predischarge adsorption consisting of molecules held by van der Waal's forces on a primary Langmuir layer on the electrodes, as a determinant of Δi was deduced from Joshi's postulate and investigated in iodine vapour enclosed in predegassed vessels. Appreciable Δi corresponding to 95% current suppression was observed immediately after the introduction of I_2 vapour into the vessel containing no chemisorption or activated adsorption, indicating thereby that the instantaneous sorption or van der Waals' adsorption was primary to Δi. Cathode-ray oscillographic studies emphasized the importance of this finding which suggested that irradiation enhanced the dissociation of surface adsorbed molecules to yield atoms and/or radicals which on account of their appreciable electron affinity inhibited the secondary emission from the cathode, to give Δi. A.

537.528/.529

313. The influence of the cathode material on measured breakdown strengths of solid and liquid dielectrics. J. J. O'Dwyer. *Austral. J. Phys.*, **7,** *No.* 3, 400–9 (*Sept.*, 1954).

An outline is given of a general method of accounting for the effect of electronic and ionic space charge in the breakdown of solid and liquid dielectrics. Detailed calculations are performed for a special model of both a liquid and a solid dielectric, and the results are compared with recent experimental work. Exact calculation is not possible, but it is shown that for some substances an effect due to cathode material may well be measurable, and the factors influencing such an effect are examined. A.

X-RAYS 537.531

537.531

314. Corrected values of tungsten *K*-series X-ray wavelengths with the 2-meter curved crystal diffraction spectrometer. P. Snelgrove, J. El-Hussaini and J. W. M. DuMond. *Phys. Rev.*, **95,** *No.* 5, 1203–4 (*Sept.* 1, 1954).

Certain minor mechanical errors occasioned by

small flexures in some components of the 2-metre curved-crystal γ-ray spectrometer were discovered recently through comparison of wavelength measurements in different orders of reflection. These errors have been corrected and redeterminations of nuclear γ- and X-ray wavelengths are in progress. In this way the following results have been obtained: W $K\alpha_2 = 213{\cdot}387 \pm 0{\cdot}010$; W $K\alpha_1 = 208{\cdot}575 \pm 0{\cdot}008$; W $K\beta_3 = 184{\cdot}785 \pm 0{\cdot}027$; W $K\beta_1 = 183{\cdot}997 \pm 0{\cdot}019$; all expressed in X.U. (Siegbahn). The agreement with other measurements, particularly Ingelstam (1937), is now well within the estimated standard deviation, and the authors' earlier results [Abstr. 2534 (1949)] are now superseded. A.

537.531 : 535.33

315. Are electric octupole lines observable in X-ray spectra? L. MAURIN. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 2, 69–72 (1954) In German.

The intensity to be expected for these lines is calculated using hydrogen wavefunctions. It is generally very small, but, as it increases with Z^{10} (Z = atomic number), they may just be observable in heavy elements. L. PINCHERLE

537.531 : 621.386.8

316. Visibility of X-ray quantum fluctuations on image intensifier radiographs. T. TOL AND W. J. OOSTERKAMP. Letter in *Nature* [*London*] **174**, 397–8 (*Aug.* 28, 1954).

In intensifier radiography, a coarse mottling of the image and a reduction in perceptibility of detail are observed, especially when the intensification factor is high and the optical magnification large. This is due to statistical fluctuations in the relatively small number of absorbed X-ray quanta and can be remedied only by increasing the number of X-ray quanta.

D. V. MABBS

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

317. On the explanation of electron emission from metals and non-metals after mechanical working and irradiation. H. NASSENSTEIN. Note in *Naturwissenschaften*, **41**, *No.* 14, 329 (1954) In German.

A short note suggesting an alternative process to those suggested by Haxel *et al.* [Abstr. 1043 (1952)] and Kramer [*Der metallische Zustand, Göttingen* (1950)] to account for enhanced electron emission from worked and irradiated surfaces. The basic assumption made is that the electrons arise from highly placed energy levels and require negligibly small amounts of energy to make their exit possible.

C. G. MORGAN

537.533

318. Field emission current densities and surface field strengths in the field-emission microscope together with methods for the determination of the cathode spike radius and shape, the magnification and resolving power. M. DRECHSLER AND E. HENKEL. *Z. angew. Phys.*, **6**, *No.* 8, 341–6 (*Aug.*, 1954) In German.

The usual formulae based on a hyperboloid cathode surface are replaced by ones derived for a field resulting from the superposition of the hyperboloid field on a hemispherical field. The radius is then proportional to $U^{3/2}$ (U-voltage for 10^{-5} A current) instead of $U^{5/4}$. The experimental methods for determining the other quantities mentioned in the title are then described. A. H. W. BECK

537.533 : 621.384.612

319. The Italian project for an electron-synchrotron. G. SALVINI. *Nuovo Cimento Suppl.*, **12**, *No.* 1, 77–100 (1954) In Italian.

537.533.3

320. Similar trajectories of charged particles in magnetic fields. V. M. KEL'MAN AND K. V. LYUBIMOV. *Izv. Akad. Nauk SSSR Ser. fiz.*, **18**, *No.* 1, 155–60 (1954) In Russian.

Conditions are found such that rays in a 2-dimensional field are functions only of initial geometrical conditions and are independent of momentum. Two particular fields satisfying these conditions are (1) $H_x = 0$, $H_y = zH_0$, $H_z = yH_0$; (2) $H_x = 0$, $H_y = 2yzH_0$, $H_z = (y^2 - z^2)H_0$. The first of these was among the cases considered by Coggeshall and Muskat (1944). The present authors show that the ray equation in the second field can be expressed as an integral, which they have solved numerically for a number of values of the parameters. A description is given of magnets which reproduce these fields and of an investigation of their behaviour as electron mirrors, by means of cathode rays of various energies.

J. C. E. JENNINGS

537.533.3 : 537.534.72 : 621.385.833

321. Some designs in electron and ion optics. J. B. LE POOLE. *Delft: Technische Hogeschool* (1954) 98 *pp.*

The booklet describes some new features of electron-optical devices developed at the Technische Hogeschool in Delft. Included are an achromatic electron-diffraction apparatus, which can be operated under pulsed conditions, a simplified electron microscope using a very short focal-length objective lens, and a new type of mass spectrograph using dynamic deflecting fields and electrostatic focusing. A separate chapter is devoted to a discussion on focusing aids for the electron microscope. M. E. HAINE

537.533.33

322. The calculation of electron lenses from given paraxial focusing properties. P. P. KAS'YANKOV. *Zh. tekh. Fiz.*, **23**, *No.* 3, 531–40 (1953) In Russian.

For an electrostatic lens, let $R = r\Phi^{\frac{1}{4}}$; then if $R(z)$ is given, $\Phi = \Phi_0 \exp\left[\pm \int_{z_0}^{z} (-16R''/3R)^{\frac{1}{2}} dz\right]$ where z_0 is the axial co-ordinate of the object. What will actually be given is the magnification and the separation of object and image; the problem of choosing a suitable functional form for R is discussed in detail, special consideration being given to the choice of such functions as those of Mathieu, Bessel and Legendre. Electrode shapes may be calculated from the axial potential by a process which is the inverse of the relaxation method. The possibility of imposing the condition that a certain primary aberration coefficient be minimized is mentioned, but is not enlarged upon.

J. C. E. JENNINGS

537.533.35

323. A β-spectrometer with great resolving power. V. M. Kel'man, D. L. Kaminskiĭ and V. A. Romanov. *Izv. Akad. Nauk SSSR, Ser fiz.*, **18**, *No.* 1, 148–54 (1954) In Russian.

The instrument is the stigmatic combination of 2 lenses and a prism, described in Abstr. 1053 (1952). A simple reconsideration of the aberration theory of the prism for virtual rays (i.e. asymptotes) leads to the following remarkable result. Let the magnetic poles be antisymmetric about $z = 0$, symmetric about $y = 0$ and let all derivatives with respect to x vanish; let s be distance along a ray and $dz/ds = \sin\gamma$, $dx/ds = \sin\alpha\cos\gamma$; then $\cos\gamma_i \sin\alpha_i - \cos\gamma_0 \sin\alpha_0 = \sin\alpha_{im} - \sin\alpha_{0m}$, where the subscripts o, i refer to object and image spaces respectively, and m refers to the median plane. This means in particular that for a family of rays with $\gamma_0 = \gamma_i = 0$ (i.e. a collimated beam so incident that the prism z-focusing is telescopic) there is no aberration in the deflection (i.e. in the change of dy/dx on refraction), irrespective of the z-height of the rays. This result is not derived from the discontinuous-field approximation, but is exact. Constructional details are given of an experimental spectrometer and results are recorded of tests on the F-line of ThB, e.g. source 10 mm × 1 mm at 90 cm from collimator; collimated beam 30 mm "high" $(z) \times 18$ mm; receiver slit 15 mm × 2 mm at 62 cm from second lens: relative half-width 0·18% after subtracting background. There is evidence that the prism field was not sufficiently independent of x.

J. C. E. Jennings

537.533.35

324. Description of a beta-spectrometer with a plane of symmetry and double focusing using iron-free coils. A. Moussa and J.-B. Bellicard. *J. Phys. Radium*, **15**, *No.* 5, 85 A–93 A (*May Suppl.*, 1954) In French.

The spectrometer employs four sets of coaxial electromagnet coils with radius, spacing and number of turns adjusted to give the required radial distribution of field for double focusing. A maximum potential of 8000 V across the four coils gives a current of up to 0·5 amp with electronic stabilization. The construction of the spectrometer chamber is described. With a source of width 5 mm, a resolution of 0·93% is obtained and a total transmission of 1%.

L. R. Shepherd

537.533.72 : 621.385.1.029.6 : 621.385.833

325. Focusing of a long cylindrical electron stream by means of periodic electrostatic fields. Ping King Tien. *J. appl. Phys.*, **25**, *No.* 10, 1281–8 (*Oct.*, 1954).

The use of a bifilar helix or a series of annular rings to produce periodic electric fields is considered. The potential distribution at the position of the electrons is expanded in a power series, and an equation of electron motion is written. The solutions obtained indicate that the flow of electrons is essentially parallel, provided that the electrons enter the focusing structure practically without transverse velocities and are distributed across the stream such that the space charge fields decrease radially toward the axis in a manner similar to that of the periodic electric fields. The method of periodic electrostatic focusing is of particular interest in connection with travelling wave tubes. The possibility of using a bifilar helix as both the slow wave and the focusing structure is discussed.

A.

537.533.73 : 548.74

Double interference of electrons with extinction of the third wave front. *See Abstr.* 644

537.533.74 : 539.153.4

Theory of collision of electrons with hydrogen atoms. *See Abstr.* 464–5

537.533.74 : 539.153.4

Atomic factors of electron scattering. *See Abstr.* 466

537.533.74 : 539.18

326. Scattering of electrons by mesons. J. de Oyarzabal. *Rev. Mexicana Fis.*, **3**, *No.* 2, 76–83 (*April*, 1954) In Spanish.

The interaction between electrons and π-mesons, occurring through an intermediate electromagnetic field, is calculated by standard methods; formulae are given for the total scattering cross-section and for the angular distribution.

L. Pincherle

537.533.75

327. Comparative study of the absorption of monoenergetic positrons and electrons in copper and cadmium. K. A. Baskova and V. M. Gorbachev. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 270–4 (1954) In Russian.

Using the same methods as in Abstr. 8776 (1951) absorption curves were compared for e^+ and e^- at energies from 260 to 2460 keV. A significantly greater absorption of electrons obtained with Cd (but not Cu) confirms the earlier finding (using Al and Pb) that the effect grows with Z. The positron selecting powers of Cd filters are deduced as function of absorber thickness and energy.

W. J. Swiatecki

537.533.75

328. Energy losses of electrons passing through an MgO foil. H. Watanabe. Letter in *Phys. Rev.*, **95**, *No.* 6, 1684–6 (*Sept.* 15, 1954).

Experiments with 15–25 kV electrons lead to a confident value of 11·4 eV for the energy gap in MgO. The general technique will probably be of use for determinations of band structures of other highly resistive materials.

C. A. Hogarth

537.533.8 : 537.311.32

329. The theory of electron impact ionization in insulating crystals. L. Tewordt. *Z. Phys.*, **138**, *No.* 5, 499–514 (1954) In German.

Ionization by conduction electrons is treated on the basis of the Fock "one-electron approximation." The total ionization probability and excess energy distribution are determined. The relevance of the work to the electrical breakdown of crystals is indicated.

C. G. Morgan

537.534

330. A potential stabilizer for accelerators of charged particles. E. Diaz Losada, A. Fernández and L. Velázquez. *Rev. Mexicana Fis.*, **3**, *No.* 2, 115–22 (*April*, 1954) In Spanish.

Fluctuations of potential in a Van der Graaff generator are often compensated by means of a discharge; an electronic device is described for the automatic regulation of such a discharge.

L. Pincherle

537.534.72

331. Single scattering of positive ions in a gas. N. V. FEDORENKO. *Zh. tekh. Fiz.*, **24**, *No.* 5, 784–96 (1954) In Russian.

Using the same rotatable magnetic analyser as in Abstr. 11135 (1954) the differential cross-sections were studied at $\theta = 2{\cdot}5$ to 15° for the passage of 5–30 keV H^+, N^+, Na^+, A^+, Kr^+, I^+, Pb^+, N_2^+, H_3^+, H_2^+, A^{++} ions through H, He, Ne, N, A or Kr gas. It is demonstrated that the processes taking place can be analysed into collisions with a change of charge of ± 1 or 0, contributing mostly in different angular ranges. In the last case it is found that deflections $\geqslant 2{\cdot}5°$ must correspond to impact parameters implying a considerable overlap of the atomic electrons. For collisions of N_2^+, H_2^+, H_3^+, dissociation takes place at $\theta \geqslant 2{\cdot}5°$. W. J. SWIATECKI

537.534.74/.75

332. Total cross sections of 208-MeV and 513-MeV protons for light elements. H. G. DE CARVALHO. *Phys. Rev.*, **96**, *No.* 2, 398–407 (*Oct.* 15, 1954).

Transmission measurements were performed with an external collimated proton beam of the University of Chicago 170-inch synchrocyclotron. Total cross-sections of the neutron and ten light elements (H and D, Li, B, Be, C, N, O, Al, S and Cl) were measured by coincidence and anticoincidence methods at proton energies of 208 and 315 MeV at several subtended angles. The cross-sections obtained include all processes except the Coulomb scattering, for which corrections were applied. The corrected cross-sections, measured at different subtended angles ("poor geometries") were plotted with their statistical uncertainties as a function of the solid angle subtended or of the angle, and extrapolated to zero degrees ("good geometry"). Only a limited number of previous investigations of the light elements at high particle energies have been made. The results found in the present study for the proton total cross-sections for the various elements were comparable to the available published neutron total cross-sections measured at the same energies. It was found, by application of the transparent optical model, that cross-sections measured were consistent with a nuclear radius $R = 1{\cdot}23A^{\frac{1}{3}} \times 10^{-13}$ cm and an absorption coefficient $K = 0{\cdot}5 \times 10^{13}$ cm^{-1}. A.

537.534.74

333. Polarization in the scattering of protons by protons. YA. A. SMORODINSKIĬ. Letter in *Zh. éksper. teor. Fiz.*, **27**, *No.* 1, 123–4 (1954) In Russian.

Experiments at 240 MeV are discussed. The experimental isotropy is taken to indicate that the $^1S_0$ and $^3P_1$ states contribute mainly to the cross-section. The polarization then affords a sensitive method of defining the phases for the $^3P_0$ and $^3P_2$ waves. G. E. BROWN

537.534.74

334. Proton-proton scattering experiments at 170 and 260 MeV. O. CHAMBERLAIN AND J. D. GARRISON. Letter in *Phys. Rev.*, **95**, *No.* 5, 1349–50 (*Sept.* 1, 1954).

The differential cross-section for laboratory scattering angles of 4·4 to 40 degrees was measured, and the results are presented graphically. The experimental results deviate from the distribution which would arise for Coulomb scattering plus a constant nuclear cross-section. J. HUGHES

537.534.74

335. Small angle proton-proton scattering at 330 MeV. D. FISCHER AND G. GOLDHABER. Letter in *Phys. Rev.*, **95**, *No.* 5, 1350–1 (*Sept.* 1, 1954).

The differential cross-section for laboratory scattering angles of 2·2 to 14 degrees was measured, and the results are presented graphically. For angles above 20° c.m., the cross-section was $3{\cdot}8 \pm 0{\cdot}25$ mb/sterad. The probable presence of interference between nuclear scattering and Coulomb scattering is discussed. J. HUGHES

537.534.74

336. Small angle *p-p* cross sections and polarization at 300 MeV. O. CHAMBERLAIN, G. PETTENGILL, E. SEGRÈ AND C. WIEGAND. Letter in *Phys. Rev.*, **95**, *No.* 5, 1348–9 (*Sept.* 1, 1954).

These were measured for angles below 20° c.m., and the results are given graphically. The polarization data is in agreement with earlier results at larger scattering angles. J. HUGHES

537.534.74

337. Polarization in *p-p* scattering at 415 MeV [±5 MeV]. J. A. KANE, R. A. STALLWOOD, R. B. SUTTON, T. H. FIELDS AND J. G. FOX. Letter in *Phys. Rev.*, **95**, *No.* 6, 1694–5 (*Sept.* 15, 1954).

A 1st scattering on C at 13° gave a 45% polarized beam which was scattered on liquid H at $\theta = 17 - 90°$ (c.m. system). If $\sigma(\theta)$ denotes unpolarized cross-section, P_H polarization on H, then $\sigma(\theta)P_H(\theta) = (0{\cdot}62 \pm 0{\cdot}14) \sin\theta \cos\theta\,[1 + (1{\cdot}0 \pm 0{\cdot}7)\cos^2\theta + (0{\cdot}63 + 0{\cdot}77)\cos^4\theta]$. W. J. SWIATECKI

537.534.74

338. Proton-proton scattering at intermediate energies. A. MARTIN AND L. VERLET. *Nuovo Cimento* **12**, *No.* 4, 483–9 (*Oct.*, 1954) In French.

This has been studied with the potential derived from the pseudoscalar theory (with pseudoscalar coupling). The validity of Born approximation in *P* and *D* states, the influence of *P-F* coupling, and of non-perturbation corrections to the potential have been investigated. A comparison with experiment shows a good agreement at 18·3 MeV, but a definite disagreement at 32 MeV. A.

537.534.74

339. The scattering of deuterons and protons by alpha-particles. R. G. FREEMANTLE, T. GROTDAL, W. M. GIBSON, R. MCKEAGUE, D. J. PROWSE AND J. ROTBLAT. Letter in *Phil. Mag.*, **45**, 1090–3 (*Oct.*, 1954).

The differential scattering cross-section of helium for 9·5 MeV protons and for 13·7 and 19 MeV deuterons has been determined using photographic plates at angles of scattering between 15° and 165°. M. A. GRACE

537.534.74 : 778.34

340. On the determination of multiple scattering from ionization tracks. H. OLSEN, H. WERGELAND AND H. ØVERAAS. *K. Norske. Vidensk. Selsk. Forhandl.*, **26**, *No.* 5, 36–40 (1953).

The 4 methods of measuring the mean square angular deflection $\langle\Phi^2\rangle$ (tangent, centre of gravity,

co-ordinate, angular) are compared systematically by applying a Fourier analysis of the track. The result is: $\langle\Phi^2\rangle_{c.g.}:\langle\Phi^2\rangle_{coord}:\langle\Phi^2\rangle_{aug}:\langle\Phi^2\rangle_{tan}=\frac{1}{20}:\frac{2}{3}:\frac{20}{35}:1$. A fifth method is mentioned. W. J. SWIATECKI

537.534.75

341. Range of nitrogen ions in emulsion. H. L. REYNOLDS AND A. ZUCKER. *Phys. Rev.*, **96**, *No.* 2, 393–4 (*Oct.* 15, 1954).

The range of nitrogen ions in Ilford C-2 emulsion was measured for energies from 4 to 28 MeV. The rate of energy loss over this entire energy region is approximately 1·5 MeV per micron. A.

537.534.75 : 537.56

342. Radiation absorption and energy loss by primary and secondary particles. F. W. SPIERS. *Disc. Faraday Soc.*, *No.* 12, 13–24 (1952).

The processes of absorption of ionizing radiation are reviewed and their relative importance is discussed in terms of quantum energy. Examples of the energies of secondary electrons are given for commonly used radiations. The modes of energy loss by fast charged particles are described and the magnitude of the energy required to produce one ion-pair is discussed in relation to particle type and speed and the properties of the absorbing medium. Some indication is given of the initial spatial distribution of the ionization. A.

537.534.8 : 537.533.8

343. Polarization of bremsstrahlung. E. G. MUIRHEAD AND K. B. MATHER. Note in *Austral. J. Phys.*, **7**, *No.* 3, 527–9 (*Sept.*, 1954).

An attempt has been made to detect polarization of 11·5 MeV synchrotron radiation by means of deuterium-loaded emulsions. Some of the experimental data appear inconsistent with theory. J. J. WILKINS

537.534.8

344. Electron emission from metals under high-energy hydrogen ion bombardment. B. AARSET, R. W. CLOUD AND J. G. TRUMP. *J. appl. Phys.*, **25**, *No.* 11, 1365–8 (*Nov.*, 1954).

Measurements of the electron emission from Mg, Al, Fe, Ni, Au and Pb surfaces bombarded by atomic (H_1) and molecular (H_2^+) hydrogen ions with energies from 0·7 to 2·0 MeV showed a diminishing emission with ion energy and little dependence on either atomic number or on the field intensity at the metal surface. Measurements of this type are of interest in connection with the mechanism of high voltage discharges in vacuum. The expected variation of secondary emission with angle of incidence and with conditioning was found. The emission ratios are compared with measurements by others at lower ion energies. A.

537.534.8 : 539.166.83

345. Auger ejection of electrons from tungsten by noble gas ions. H. D. HAGSTRUM. *Phys. Rev.*, **96**, *No.* 2, 325–35 (*Oct.* 15, 1954).

Experimental investigation of electron ejection from atomically clean tungsten by singly and multiply charged ions of the noble gases is reported. Total electron yield, γ_i, and distribution in kinetic energy of the secondary electrons have been measured. Ion energies range from 10 to 1000 eV for singly charged ions. γ_i is found in each case to be roughly constant over this interval although the variations observed are significant and can be accounted for by theory. γ_i values of 0·293, 0·213, 0·094, 0·047 and 0·018 were obtained for 10 eV He^+, Ne^+, A^+, Kr^+ and Xe^+ ions, respectively. Comparison with theory makes it quite clear that for 10 eV ions essentially all electrons observed are ejected by a process of Auger neutralization in which the interaction of two conduction electrons causes one electron to neutralize the ion in the ground state and the other to be excited into the continuum above the filled band. The observed γ_i is determined by the probability that these excited electrons escape from the metal. In the case of Ne^+, indications are that as ion energy increases toward 100 eV a two-stage electronic transition process occurs in a small fraction of the encounters. In this process the ion is first resonance-neutralized to an excited state and the resulting excited atom is subsequently de-excited in an Auger ejection process. Variation of the electron energy distribution with ion energy has been investigated. Careful measurement for Ne^{20} and Ne^{22} at 200 eV shows γ_i to be independent of nuclear mass. Results of γ_i and energy distribution measurements for electrons from multiply charged ions up to Xe^{5+} are also reported. A value of $\sim$6·3 eV for the energy of the Fermi level above the ground state in the conduction band in tungsten comes out of this work. A.

537.534.8 : 539.166.83

346. Theory of Auger ejection of electrons from metals by ions. H. D. HAGSTRUM. *Phys. Rev.*, **96**, *No.* 2, 336–65 (*Oct.* 15, 1954).

Electrons ejected from atomically clean metals by slow ions of the noble gases arise in Auger transitions which involve either the direct neutralization of the ion or the de-excitation of an excited atom. A theory of these processes is presented in which the form of the distribution in energy and relative total yield, γ_i, of ejected electrons are derived. Matrix elements are not evaluated from first principles, but specific use of experimental results at two points in the theory leads to a determination of the dependence of the matrix element on distance between the atomic particle and the metal surface and the angle between the excited electron's velocity and the surface normal. Inclusion of the effects of variation of atomic energy levels near the metal surface and the Heisenberg uncertainty principle makes it possible to account in some detail for the experimentally observed energy distributions as well as the variation of these and of γ_i with ion kinetic energy. The effect upon the resonance ionization and neutralization processes of the variation of atomic energy levels near the metal surface has also been investigated. The theory predicts a critical distance from the metal surface outside which resonance neutralization and inside which resonance ionization are possible. It has also been possible for the specific case of noble gas ions on tungsten, used as an illustrative example, to determine the relative proportion of electrons ejected by each of the possible Auger processes, to estimate γ_i values for ions incident upon a metal with thermal energies, and to fix limits on the width of the filled portion of the conduction band in the metal. The role of the state density function in the metal and the effect of possible

variation of the matrix element with electron energy in the band are also investigated. A.

537.534.9 : 541.15

Cyclotron techniques for radiation damage studies. *See Abstr.* 605

DISCHARGE TUBES . COUNTERS 537.54

537.542

347. Operating characteristics of a high yield rf ion source. H. P. Eubank, R. A. Peck, Jr and R. Truell. *Rev. sci. Instrum.*, **25**, *No.* 10, 989–95 (*Oct.*, 1954).

An r.f. source has been constructed, which yields up to 15 mA of hydrogen ion current consisting of 80–90% protons. The ion current yield has been studied as a function of r.f. power and frequency, gas pressure and d.c. (extracting) voltage. These relationships are correlated with internal phenomena of the gas discharge and of ion extraction therefrom. A.

537.542 : 537.534

348. A radiofrequency ionization chamber. F. Alba Andrade, E. Diaz Losada, A. Fernández and I. Gómez. *Rev. Mexicana Fis.*, **3**, *No.* 2, 107–14 (*April*, 1954) In Spanish.

A preliminary description of an apparatus which produces ions for particle accelerators by means of the ionization caused by r.f. waves. L. PINCHERLE

537.542

349. Optimum shape for cylindrical ionization chambers. R. K. Clark and S. S. Brar. *Nucleonics*, **12**, *No.* 8, 28–9 (*Aug.*, 1954).

Correction factors for the inverse square variation in ionization density in a cylindrical chamber, due to the dimensions being comparable with the distance to the source, are derived for the cases of both external and internal sources set on the axis of the chamber. The corrections are least when the height of the cylinder is about 0·75–0·80 times the diameter.

L. R. SHEPHERD

537.542

350. K–9: a large 4π gamma-ray detector. M. A. Van Dilla, R. L. Schuch and E. C. Anderson. *Nucleonics*, **12**, *No.* 9, 22–7 (*Sept.*, 1954).

The detector consists of a liquid scintillator contained between two coaxial cylinders, 9 in. internal dia. and 17 in. external dia. with a length 28 in. Eight photomultipliers, placed four at each end, detect the light pulses in the scintillator and the surfaces of the annular container are coated with light enamel to allow light collection from all parts of the volume. The subject under test is placed inside the inner cylinder, there being room for a 9 kg dog. Operational characteristics, investigated with Ra^{226} and Th^{228} sources, are described. Response is almost independent of source position inside the inner cylinder. A Ra content of 0·002 mg, in a dog, can be detected. L. R. SHEPHERD

537.542

351. Diffusion cloud chambers for cosmotron experiments. W. B. Fowler, R. P. Shutt, A. M. Thorndike and W. L. Whittemore. *Rev. sci. Instrum.*, **25**, *No.* 10, 996–1003 (*Oct.*, 1954).

Two diffusion cloud chambers operating with H_2 or He at pressures up to 300 lb/in.^{2} have been built primarily for use at the cosmotron. One is a 16 in. diameter chamber operated in a 10 500 gauss field. The other chamber has an effective length of 6 ft, width of 11 in., and no magnetic field. Photographs obtained with the long chamber are scanned in a special projector, which foreshortens beam tracks so that up to 75% of scanning time per event is saved. Beams of protons, neutrons and mesons suitable for experiments with these chambers have been obtained. A considerable number of nuclear interactions of beam particles in the cloud chamber gas have been observed. Angles, densities and momenta of secondary particles have been measured with acceptable accuracy. Consequently these cloud chambers provide a useful tool for the study of high-energy nuclear interactions. A.

537.542

352. The detection of electron pairs in a cloud chamber with internal counters. P. J. Campion and W. T. Davies. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 941–3 (*Oct.*, 1954).

Details of construction and operation of a chamber triggered by two internal proportional counters in coincidence. J. J. WILKINS

537.542

353. The resolving time of an internal counter controlled Wilson chamber. P. J. Campion and W. T. Davies. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 944–6 (*Oct.*, 1954).

See preceding abstract. Photographs are given to show the time discrimination (~200 μsec) afforded by the expansion of the counter ionization bead.

J. J. WILKINS

IONIZATION . THERMIONICS 537.56/.58

537.562

354. On a new action of a uniform magnetic field on a gas (photo-) cell. R. Birebent. *Ann. Fac. Sci. Univ. Toulouse*, **15**, 187–94 (1951) In French.

The current passed by a plane-cathode gas-filled photocell is significantly increased by a uniform magnetic field perpendicular to the plane of the cathode. For a sufficient strength of the field, the current only depends on the voltage and the illumination. The current-voltage characteristic can be represented by an exponential function incorporating the ionization potential of the gas. This potential also appears in the expression relating the currents with and without the magnetic field. A.

537.568 : 551.510.535

355. On negative ions of molecular oxygen in the *D*-layer. D. R. Bates and H. S. W. Massey. Note in *J. atmos. terrest. Phys.*, **2**, *No.* 4, 253–4 (1952).

Recent measurements of the rate of attachment of slow electrons to O_2 by Biondi (1951) indicate an attachment coeff. several orders of magnitude smaller than previously assumed. This requires considerable

reduction in the *D*-layer values of the negative-ion/electron ratio given in Abstr. 2285 (1952), necessitating revision of conclusions regarding the transverse conductivity and recombination processes in the *D*-layer. G. M. BROWN

537.585 : 537.534.74

356. Mass spectrometric study of the evaporation products of strontium oxide on platinum. P. W. Bickel and L. V. Holroyd. *J. chem. Phys.*, **22**, *No.* 11, 1793–5 (*Nov.*, 1954).

The vapour above the SrO–Pt system was bombarded with electrons and the ion fragments analysed by a mass spectrometer. Evaporator temperatures ranged from 1600°K to 1800°K. Log Sr^+ *v.* $1/T$ plots were found to be time-dependent initially. Eventually the plots became stable, and could be represented by two straight lines having a slope of 60 kcal/mole at the higher temperatures and of 138 kcal/mole at the lower temperatures. The appearance potential for Sr^+ was approximately 5 V. The ratio of Sr^+ to SrO^+ was between 10 and 100. These results indicate that thermal dissociation of SrO took place. An explanation based on a diffusion-limited mechanism is offered for the smaller slope of the upper part of the log Sr^+ *v.* $1/T$ plot. The behaviour of the SrO–Pt system is compared with that of the BaO–Pt system. The latter system does not appear to exhibit thermal dissociation. A.

COSMIC RAYS 537.591

537.591 : 550.385

357. On the behaviour of cosmic rays in magnetic storms. A. Ehmert. *Naturwissenschaften*, **41**, *No.* 14, 317–18 (1954) In German.

An examination of cosmic-ray and magnetic-field data for the storm of July 26–7 (1946) in the light of Chapman's theory. J. M. HOUGH

537.591.1

358. On the mass spectra of cosmic ray particles at sea level. A. I. Alikhanov and G. P. Eliseev. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 368–78 (1953) In Russian.

A magnetic mass spectrograph is described. The particle momentum is fixed by five successive trays of counters and the particle is brought to rest by laminar absorbers. The apparatus allows resolution of the π and μ spectra. Measurements show masses intermediate between π and proton masses and a few masses greater than the latter. G. E. BROWN

537.591.1

359. The spectrum of π and μ-mesons in cosmic rays. G. M. Garibyan and I. I. Gol'dman. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 257–63 (1954) In Russian.

The number of μ's generated with a given momentum (in the range 10^8 to 40×10^8eV/c) at heights of 0, 1·9, 3·5, 4·3, 5·5, 9·3 km is deduced from the experimental intensity of μ's as function of height, taking account of ionization losses and scattering. A function giving the probability that a μ observed at x with momentum p was created at x_0 is derived. Finally the implied π spectrum is reconstructed and comparison with data from emulsions shows agreement. W. J. SWIATECKI

537.591.1

360. On the total intensity and the differential momentum spectra of the nucleon component of the cosmic radiation measured by means of nuclear emulsions in the neighbourhood of the equator. Tsai-Chü and M. Morand. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 5, 415–18 (*Aug.* 2, 1954) In French.

The momentum spectrum of slow protons, taking into account the dependence on zenith angle, shows a secondary maximum in the low-energy region. The latitude effect for the protons is only half as big as that for neutrons. H. ELLIOT

537.591.1

361. Momentum distribution and charge ratio of μ-mesons at zenith angles in the east-west plane. J. R. Moroney and J. K. Parry. *Austral. J. Phys.*, **7**, *No.* 3, 423–8 (*Sept.*, 1954).

The momentum distribution and charge ratio of the penetrating component of the cosmic radiation at sea-level have been determined over the momentum range 0·24–58 BeV/c at a geomagnetic latitude of 47°S. The measurements were performed in the vertical direction and at zenith angles of 30° and 60° in the eastern and western azimuths. An attempt has been made to calculate the sea-level spectra at these zenith angles on the basis of a simplified continuous production process. A comparison with the measurements indicates that, although the calculations describe the general behaviour, the quantitative agreement is unsatisfactory. The charge ratios measured at zenith angles in the western azimuth increase, and those in the eastern azimuth decrease, as the momentum decreases. This is explained as a secondary effect due to curvature of the meson trajectories in the magnetic field of the earth. Information has been obtained on the dependence of the exponent n on the momentum, where n is defined by the intensity-zenith angle relation, $I_\theta = I_0 \cos^n \theta$. From the value 3·3 at 0·3 BeV/c, n approaches zero at high momentum. The radiation is approximately isotropic above 20 BeV/c. A.

537.591.1

362. On the nuclear emulsion method for the study of the neutron component of the cosmic radiation. M. Curatolo, M. M. Indovina Addario, D. Palumbo and M. Santangelo. Letter in *Nuovo Cimento*, **12**, *No.* 3, 460–3 (*Sept.*, 1954) In Italian.

Photographic emulsions were loaded with lithium borate, and placed between blocks of paraffin. They were exposed at sea-level in Palermo, and at 4500 metres in the Alps. The absolute flux of neutrons calculated from the B reactions differs considerably from that calculated from the Li reactions, however, the ratio of the fluxes between mountain altitude and sea-level shows reasonable agreement between the two types of reaction. The mean free path for the radiation producing the neutrons is deduced as 158 ± 5 g/cm^{-2}. P. ROTHWELL

537.591.1

363. Primary alpha particles in the cosmic radiation near the geomagnetic equator. M. A. Pomerantz. Letter in *Phys. Rev.*, **96**, *No.* 6, 1691–2 (*Sept.* 15, 1954).

Gives a preliminary amount of measurements of the primary α-particle flux carried out in India using a combination of G.M. counters and an ionization

chamber. The values obtained are 49 ± 13 at latitude 3° and 81 ± 22 particles m^{-2} sec^{-1} $sterad^{-1}$ at latitude 18°. It is concluded that the flux of protons with $1{\cdot}5 < E < 15$ BeV and of α-particles with $0{\cdot}3 < E < 7$ BeV can be represented by an integral spectrum of the form $N(>E) = k(1 + E)^{-1{\cdot}2}$ where E is the kinetic energy per nucleon and $k = 4000$ for the protons and 450 for the α-particles. H. ELLIOT

537.591.1

364. Primary cosmic ray spectrum deduced from an analysis of jets. A. ENGLER AND U. HABER-SCHAIM. Letter in *Phys. Rev.*, **95**, *No.* 6, 1700–1 (*Sept.* 15, 1954).

The integral energy spectrum in the region 65–100 Mc^2 is shown to be of the form $N(>E) \sim E^{-s}$. The energy has been estimated by two different methods and the value of s is found to be in the neighbourhood of $1{\cdot}5$. H. ELLIOT

537.591.1

365. A cloud chamber analysis of cosmic radiation at 3500 m. B. Results on the hard and soft components. A. LOVATI, A. MURA, C. SUCCI AND G. TAGLIAFERRI. *Nuovo Cimento*, **12**, *No.* 4, 526–38 (*Oct.*, 1954).

For Pt I, see Abstr. 7761 (1953). A multiplate cloud chamber has been operated at 3500 m, yielding 16 000 photographs of random expansions. This paper is intended to investigate some questions pertaining to the general cosmic-ray phenomenology. In particular, the zenith angle dependence of the directional intensities of both hard and soft component is found to follow a squared cosine law. In the range 300–2000 MeV, the differential energy spectrum of the soft component is shown to be well represented by a power law with exponent $-2{\cdot}5$. The rate of production of nuclear disintegrations in lead and the correlation between the disintegrations and other events are examined. A.

537.591.15

366. Atmospheric effects on Auger showers. A. DAUDIN AND J. DAUDIN. *J. atmos. terrest. Phys.*, **3**, *No.* 5, 245–57 (*June*, 1953) In French.

An analysis of the time variations of the frequency of air showers at an altitude of 2860 m has been carried out using two groups of showers recorded respectively by counters separated by 5 m and 80 m. The effects of barometric pressure and air temperature on the shower rate are discussed and it is pointed out that after correcting for temperature and pressure there still remains an irregular variation the cause of which is not known. H. ELLIOT

537.591.15

367. Investigation of the theory of cascades. I. L. YANOSHI [JÁNOSSY]. *Zh. éksper. teor. Fiz.*, **26**, *No.* 4, 386–404 (1954) In Russian.

A general and unified presentation of the method developed earlier [Abstrs. 4336, 8845 (1950)] is given and the generating function is derived. G. E. BROWN

537.591.15

368. Investigation of the theory of cascades. II. L. YANOSHI [JÁNOSSY]. *Zh. éksper. teor. Fiz.*, **26**, *No.* 5, 518–36 (1954) In Russian.

Results previously obtained by various authors giving equations on the moments of the distribution are derived from the G-equation obtained in Pt I. The article is a unified presentation of known results. G. E. BROWN

537.591.15

369. The residual range of delayed particles in extensive air showers. V. C. OFFICER AND P. J. ECCLES. *Austral. J. Phys.*, **7**, *No.* 3, 410–22 (*Sept.*, 1954).

The arrival times of the penetrating particles of extensive air showers relative to that of the electrons have been studied by means of short-reaction-time G.M. counters. A 50 channel hodoscope has been used to identify the penetrating particles and measure their residual ranges where these lay between 15 and 30 cm of lead. From observations on 782 showers of median density 70 particles m^{-2} in which a penetrating component was detected, it was deduced that between 3 and 9 particles in 10^4 shower particles from showers of median density 28 particles m^{-2}, have delays $< 5 \times 10^{-8}$ sec and are able to penetrate 15 cm of lead. It follows that 81–94% of the delayed particles found by Jelley and Whitehouse [Abstr. 6916 (1954)] without the use of absorbers, must be stopped by 15 cm of lead. This indicates a height of production below $0{\cdot}8$ km for at least half of these particles. Two of the penetrating delayed μ-mesons were stopped in the lead, and their heights of production calculated to be $1{\cdot}0^{+0{\cdot}7}_{-0{\cdot}4}$ km and $4{\cdot}7^{+4{\cdot}5}_{-2{\cdot}2}$ km on the assumption that the delays were due to velocity differences. Thirty other μ-mesons for which the individual time lags were not significant were also stopped in the lead and gave a mean delay indicating production below an altitude of 250 m. The remaining 208 μ-mesons which did not stop could not be assigned a height of production. One delayed proton was found in the total of 29 delayed events observed, and nine events could have been oblique particles lagging on the electrons by virtue of path differences. A.

537.591.15

370. Remark on an unusual cosmic ray event. E. CORINALDESI. *Nuovo Cimento*, **12**, *No.* 4, 571–2 (*Oct.*, 1954).

Discusses the interpretation of a photon shower recently observed by Schein *et al.* at an altitude of 100 000 ft. It is pointed out that if this event is interpreted as being due to the annihilation of an anti-proton the probability of production of the observed number of photons is very low, possibly as low as that for the event being a fluctuation in a normal electron-photon cascade. H. ELLIOT

537.591.5

371. East-west asymmetry and angular distribution of protons and mesons. N. N. KOCHARYAN, M. T. AĬVAZYAN, S. D. KAĬTMAZOV AND Z. A. KIRAKOSYAN. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 364–7 (1953) In Russian.

Protons at 3200 m of $p > 9 \times 10^8$ eV are stopped in lead and copper blocks and show an angular distribution $N = N_0 \cos^n \theta$ with $n = 6{\cdot}3 \pm 1{\cdot}4$, but no east-west effect. A significant east-west asymmetry for mesons is observed. G. E. BROWN

537.591.5

372. On the 27-day recurrence of the cosmic-ray diurnal variation. S. YOSHIDA AND I. KONDO. *J. Geomagn. Geoelect.*, **6**, *No.* 1, 15–21 (*March*, 1954).

27-day recurrence was found from the analysis of

the data observed at Huancayo during the period 1936–1940. Similar analysis was done on the daily mean values of cosmic-ray intensity and geomagnetic activities. Among them the recurrence of the cosmic-ray diurnal variation was the most persistent, and that of the daily mean cosmic-ray intensity was the next. It is suggested that most of the cosmic-ray diurnal variation may be interpreted as the storm effect. A.

537.591.5

373. Anisotropy of cosmic rays observed with an alt-azimuth telescope. Y. Sekido, S. Yoshida and Y. Kamiya. *J. Geomagn. Geoelect.*, **6**, *No.* 1, 22–33 (*March*, 1954).

Intensity distribution of cosmic rays over the celestial sphere was scanned with an alt-azimuth counter telescope of a narrow angular resolution, kept nearly horizontal so that the effective cosmic-ray particles were free from complicated geomagnetic deflection. The result suggests the existence of narrow anisotropies, i.e. something like point sources. The charge and the average momentum of the cosmic-ray particles, with which the narrow anisotropies were distinguished, were observed to be positive and 2 stormers respectively. A.

537.591.5

374. Geomagnetic effects of the μ meson component of cosmic radiation at sea level. I. F. Quercia and B. Rispoli. *Nuovo Cimento*, **12**, *No.* 4, 490–518 (*Oct.*, 1954).

In order to investigate processes of creation of mesons by primary radiation and the hypothetical presence of negative particles in the primary radiation, two experiments have been carried out at high latitude (Rome, 42°) and low latitude (Bombay, 9°): (1) "charge excess experiment"; (2) "absorption spectrum experiment" under water and in the open air. The East-West asymmetry, the latitude effect, the charge excess have been studied as a function of zenithal angle. Some conclusions are the following: (*a*) the measured negative excess in the E direction can be explained without introducing the hypothesis of negative primary particles; (*b*) the energy dependence of the positive excess is not in contradiction with Heitler's theory; (*c*) the latitude effect is about 15% in the vertical direction for mesons of energy greater than 500 MeV and seems to increase in the E direction, and to decrease in the W direction with increase of zenithal angle; (*d*) the ratio between the energy of the created mesons and the energy of the protons is of the order of 0·2. A.

537.591.5

375. Cycle of world-wide changes in the daily variation of meson intensity. V. Sarabhai, U. D. Desai and D. Venkatesan. *Phys. Rev.*, **96**, *No.* 2, 469–70 (*Oct.* 15, 1954).

The study by Sarabhai and Kane of the world-wide changes in the daily variation of meson intensity has been extended by an analysis of unpublished Carnegie Institution data, kindly supplied by Dr. Forbush. Comparison of Carnegie Institution measurements at Huancayo and Cheltenham for the period 1937 to 1952 reveals high correlation between changes of the times of maxima at the two stations. The changes of amplitudes of the daily variations are not equally consistently related. The change of intensity of the coronal 5303 Å emission line exhibits the major features seen in the change of the daily variation of meson intensity. Both follow the usual 11-year solar cycle of activity. A.

537.591.8

376. Correlation of nuclear disintegrations caused by cosmic rays. M. di Corato, R. L. Setti, M. Panetti, P. Pinto and A. Milone. *Nuovo Cimento*, **12**, *No.* 4, 548–57 (*Oct.*, 1954) In Italian.

The statistical analysis of the distribution of about 3000 cosmic-ray stars in nuclear emulsions has demonstrated the presence of a correlation between them, giving a non-random distribution of the stars. The magnitude of the effect and its variation with the inverse distance between the stars suggests that it is due to secondary interactions produced by fast neutrons emitted from the stars in the emulsion. A.

537.591.8 : 551.593.9

377. On Cherenkov radiation of cosmic ray particles in the atmosphere. V. I. Gol'danskiĭ and G. B. Zhdanov. *Zh. éksper. teor. Fiz.*, **26**, *No.* 4, 405–16 (1954) In Russian.

The contribution of this radiation to the continuous spectrum of the luminosity at night is calculated and found to contribute less than 10%, in agreement with previous estimates [Abstr. 4347 (1949)]. It is shown that, however, a single burst of radiation could be observed by a registering device (e.g., photomultiplier) provided the radius of the collector is large and the resolution short, $\sim 10^{-8}$ sec. The observation of Cherenkov radiation from wide air showers is shown to afford a sensitive means of detecting these showers where the density of particles is so low as to make detection by counters difficult. The amplitude of radiation in this case is given as a function of distance from the axis of the shower. G. E. BROWN

MAGNETISM 538

538.082/.083 : 538.122

378. The visual manifestation of magnetic fields. H. König. *Naturwissenschaften*, **41**, *No.* 15, 341–6 (1954) In German.

A review of the following topics: Use of iron filings, use of colloidal iron oxide powders in Bitter pattern experiments, results of such experiments and their interpretation, electron diffraction and other methods. 21 references. E. P. WOHLFARTH

538.082/.083 : 538.122

379. Use of a gas discharge tube with a point cathode for the visual determination of the form of the lines of force of a strong magnetic field. M. Ardenne. *Zh. éksper. teor. Fiz.*, **25**, *No.* 6 (12) 749–50 (1953) In Russian.

An advantage over the electrolytic tank is that the effects of saturation are not lost. The discharge tube is filled with A or some other gas at 10^{-1} to 10^{-2} mm Hg. In an early form the cathode was of Al, 0·3 mm in dia. and 0·5 mm long. Finer lines

were obtained with a hot cathode, e.g. < 1 mm width at 1000 gauss. The tube is placed at successive positions in the field and is photographed, if necessary stereoscopically. Simultaneous use of several tubes facilitates observations of fields varying at audio-frequency. J. C. E. JENNINGS

538.083.9 : 538.214

380. A new method for measuring the complex susceptibility by magnetic resonance absorption in the ultra-short-wave region. W. MÜLLER-WARMUTH. Note in *Naturwissenschaften*, **41**, *No.* 16, 368 (1954) In German.

It is suggested that a h.f. bridge could use a magnetic resonance absorption (nuclear or electron) system as detector, the magnetic field modulation making possible low-frequency amplification and display on an oscilloscope screen for null detection of the bridge balance. D. H. WHIFFEN

538.221

381. Temperature dependence of the magnetic spectra of NiZn ferrites in the radio-frequency range. L. A. FOMENKO. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1 (7) 107–14 (1953) In Russian.

See also Abstr. 5898 (1952). The effect of temperature on the dispersion and absorption bands in the magnetic spectrum was studied for a solid solution of NiZn ferrites (initial permeability 2140 G/Oe at 20°C) in the radio-frequency range 0·05–60 Mc/s and at temperatures from −180 to +99°C. It was shown that the NiZn ferrite investigated had a continuous magnetic spectrum whose frequency band of magnetic relaxation remained in the radio-frequency range and was shifted towards lower frequencies as the temperature increased (up to the Curie point). This regularity was also observed at temperatures above that of the thermal maximum of permeability.

F. LACHMAN

538.221

382. Variation with induction of the diffusion-viscosity magnetic field. P. BRISSONNEAU. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 4, 346–9 (*July* 26, 1954) In French.

Gives results of magnetic viscosity measurements on an iron specimen containing $7{\cdot}5\times10^{-3}\%$ C by weight. According to Néel's theory the relaxation mechanism differs for 90° and 180° boundaries, giving two branches in the curve of the viscosity field as a function of induction if both types of boundary are present. A maximum was observed at $B =$ 50 gauss, the field then decreasing to much lower values at higher inductions (up to 6000 gauss). The 180° domain thickness is deduced from the measurements, and the value so obtained (8 μ) agrees with the directly measured powder pattern value.

E. P. WOHLFARTH

538.221

383. Transient phenomena in a ferrite. S. MATZ. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 6, 487–8 (*Aug.* 9, 1954) In French.

Gives results of measurements of the complex permeability of a Ni–Zn ferrite as a function of time (several seconds to several hours) at temperatures between −196° to 20°C, at frequencies 0·1 to 1·0 Mc/s and in various field strengths. The results are interpreted on the basis of Néel's theory of magnetic viscosity by diffusion, here of electrons between the lattice sites occupied by ferric and ferrous ions.

E. P. WOHLFARTH

538.222

384. On the shape of the curves of paramagnetic resonance. R. LACROIX. *Helv. phys. Acta*, **27**, *No.* 1, 283–308 (1954) In French.

The theoretical shapes of curves of χ' and χ'' as a function of frequency and as a function of the magnetic field at fixed frequency are given for Gaussian, Lorentzian and mixed line shapes including the cases with H line width parameter. The theory of the experiments in which the sample cavity is compared in frequency and Q with a second cavity using magic T arrangements, is given. Despite errors caused by the use of powders, of salts with two ions per unit cell, etc., moderate agreement with the Lorentzian shape is found for $CuSO_4 . 5H_2O$ with line width 1400 Oe from measurements at 6 to 78 Mc/s and at 9375 Mc/s. For $MnCl_2 . 4H_2O$ with line width 2500 gauss, departures from the Lorentzian shape are explained by the mixed Gaussian/Lorentzian form. D. H. WHIFFEN

538.222

385. Paramagnetic resonance absorption in sodium plutonyl acetate. C. A. HUTCHISON, JR AND W. B. LEWIS. Letter in *Phys. Rev.*, **95**, *No.* 4, 1096 (*Aug.* 15, 1954).

Electron resonance at 4°K for various orientations of a single crystal gives $g_{\parallel} \simeq 5{\cdot}9$, $g_{\perp} \simeq 0{\cdot}0$ with reference to the direction of the linear PuO_2^{++} ion. This agrees with the expected values, 6 and 0, for two unpaired electrons in an f shell and agrees with the susceptibility measurements. D. H. WHIFFEN

538.222

386. Overhauser effect in a free radical. H. G. BELJERS, L. VAN DER KINT AND J. S. VAN WIERINGEN. Letter in *Phys. Rev.*, **95**, *No.* 6, 1683 (*Sept.* 15, 1954).

The Overhauser effect, whereby saturation of electron resonance enhances simultaneous nuclear resonance, has been observed in diphenyl–picryl–hydrazyl with up to 8 watts microwave power at which the proton resonance signal is enhanced up to 6 times without change of line width. D. H. WHIFFEN

538.222

387. Electron spin resonance of an impurity level in silicon. A. HONIG AND A. F. KIP. Letter in *Phys. Rev.*, **95**, *No.* 6, 1686–7 (*Sept.* 15, 1954).

A single Gaussian electron resonance line was observed for Si with Li impurities at $7\times10^{16}/cm^3$, the width, 1 Gauss, being consistent with the impurity ionization energy of 0·033 eV and hyperfine broadening by the Si^{29} magnetic moments. D. H. WHIFFEN

538.222

388. Paramagnetic resonance, a new property of coal-like materials. J. UEBERSFELD, A. ÉTIENNE AND J. COMBRISSON. Letter in *Nature* [*London*] **174**, 614 (*Sept.* 25, 1954).

Essentially free electron paramagnetic resonance has been found with varying intensity in a range of coals, heated coals, decomposed sugars, etc.

D. H. WHIFFEN

538.222

389. Paramagnetic resonance absorption in triphenylmethyl and dimesitylmethyl. H. S. Jarrett and G. J. Sloan. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1783–4 (*Oct.*, 1954).

21 groups of hyperfine lines were observed in the electron resonance spectrum of triphenylmethyl solutions in benzene at 0·001 M and about 60 lines with dimesitylmethyl. The structure is probably due to the interaction of the H moments with the electrons through the chemical bonds. D. H. WHIFFEN

538.222

390. A nuclear inductor for measurements of thermal relaxation times in liquids. G. Chiarotti, G. Cristiani, L. Giulotto and G. Lanzi. *Nuovo Cimento*, **12**, *No.* 4, 519–25 (*Oct.*, 1954).

A device for measurements of nuclear relaxation time in liquids in the range from 10^{-2} sec to the longest observable time is described. Two equivalent methods are used which are based on the record of "in phase" signals due to the total reversal of the nuclear magnetization. A.

538.24 : 537.312.62

391. Magnetization of tin at the superconducting transition. J. C. Thompson and C. F. Squire. *Phys. Rev.*, **96**, *No.* 2, 287–91 (*Oct.* 15, 1954).

Measurements have been made of the steady state magnetization of a tin cylinder in the presence of an external magnetic field and with an externally supplied current at the transition to superconduction. In accord with earlier work in Germany, a longitudinal flux in excess of that caused by the external field is observed for certain combinations of external field and current. The dependence of the effect on the external parameters is given and it is shown that the metal is not in the pure superconducting state. No satisfactory theory for the effect has been found, but some numerical relationships have been computed. A.

538.249 : 538.652 : 548.7

392. Derivation of magnetostriction and anisotropic energies for hexagonal, tetragonal, and orthorhombic crystals. W. P. Mason. *Phys. Rev.*, **96**, *No.* 2, 302–10 (*Oct.* 15, 1954).

In order to determine the measurements necessary to characterize the anisotropic energy and the saturation magnetostriction in hexagonal cobalt, a phenomenological derivation has been given for the equations which characterize the effects. Out to fourth-rank tensors, the results are the same as those for circular symmetry and it requires two constants to specify the anisotropic energy and four to specify the magnetostriction. When sixth-rank tensors are evaluated, a characteristic hexagonal symmetry appears. It requires four constants to characterize the anisotropic energy and nine to characterize the magnetostriction. These constants can be measured by using two oriented slabs. Four of the constants can be determined by measurements parallel to the saturation magnetization, four when the magnetostriction is perpendicular to the magnetization and one when they are 45° apart. In the Appendix the first approximations for the magnetostrictive and anisotropy energies are derived for tetragonal and orthorhombic crystals. A.

538.249 : 538.652 : 548.7

393. Magnetostriction and crystal anisotropy of single crystals of hexagonal cobalt. R. M. Bozorth. *Phys. Rev.*, **96**, *No.* 2, 311–16 (*Oct.* 15, 1954).

Magnetostriction at saturation has been measured in various crystallographic directions in a single crystal of cobalt. Results are described by Mason's formula with 4 constants, which are now evaluated. Magnetization causes contractions as large as 100×10^{-6}, and expansions up to 150×10^{-6}, depending on crystallographic direction. A fractional decrease in volume, associated with domain orientation, is observed to be as large as 26×10^{-6}. Superposed on this contraction is a small isotropic increase in volume of $0{\cdot}6\times10^{-9}$ per oersted. Magnetic crystal anisotropy constants are determined and used in a calculation of the magnetostriction as dependent on the magnitude of the field applied to a disk with given demagnetizing factor. Calculation and observation agree, and show that the direction and magnitude of magnetization and of true field can be calculated in any applied field as long as it is considerably above the coercive force. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 530.145

On the motion of space charges according to Dirac's theory. *See Abstr.* 47

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 535.31

Stepwise transition from wave optics to ray optics in inhomogeneous anistropic absorbing media. *See Abstr.* 163

538.561

394. The excitation spectrum of an electron plasma in a periodic field of ions. P. S. Zyryanov. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4 (10) 441–7 (1953) In Russian.

Small oscillations ("$\varepsilon \ll 1$") of a classical electron gas described by a distribution function $f(r,v,t)$ are studied when the equilibrium distribution function $F(r, v)$ is almost constant in space ($\alpha \ll 1$). The equation for $\partial f/\partial t$ is linearized and both space- and time-dependences are Fourier analysed. An infinite system of equations results—the condition for the existence of a solution gives the spectrum of frequencies $\omega(k)$. This can be found explicitly by expanding in powers of $\varepsilon\alpha$. The resulting $\omega(k)$ shows a structure of bands whose positions are related to the Laue–Bragg conditions. It is stated that quantization [see Abstr. 5309 (1953)] does not change the above qualitative features. See also Abstr. 5921–2 (1952). W. J. Swiatecki

538.566 : 535.12 : 534.21

Criterion of the applicability of geometrical optics to problems of the propagation of waves through a medium characterized by slight refractive index variations. *See Abstr.* 124

538.566

395. A further note on dual integral equations and an application to the diffraction of electromagnetic waves. C. J. TRANTER. *Quart. J. Mech. appl. Math.*, **7**, *Pt* 3, 317–25 (*Sept.*, 1954).

A previous solution [Tranter: *Quart. J. Mech. appl. Math.*, **3**, 411 (1950)] is extended to cover cases in which the order of the Bessel function kernel is not zero. As an example, the solution is applied to a problem in the diffraction of electromagnetic waves by a plane slit and some criticisms are made of a recent discussion [Abstr. 5703 (1952)] of this problem. A.

538.566

396. Elliptical polarization of an electromagnetic wave. M. BOUIX. *Ann. Télécomm.*, **9**, *No.* 10, 275–81 (*Oct.*, 1954) In French.

The conditions for elliptical polarization are examined and it is shown that the state of the wave at any given point in space may be specified completely by either of two complex numbers p and q, related by the equation $q = (1 - p)/(1 + p)$. This relationship is identical to that used in the construction of a Smith chart. This in turn suggests representation by means of the Poincaré sphere. It is shown that the wave equations (derived from the Maxwell equations in the usual manner) are satisfied by a solution which represents an elliptically polarized plane wave. Gauss's divergence theorem (here attributed to Ostrogradsky) is used to obtain the Poynting vector and hence describe the energy relationships. Finally the wave equations are rewritten in terms of the [Lorentz] vector and scalar potentials. The paper is the first of three discussing properties of elliptically polarized waves and radiators. J. M. C. DUKES

538.566

397. An approximate method for the calculation of propagation constants for inhomogeneously filled waveguides. L. G. CHAMBERS. *Quart. J. Mech. appl. Math.*, **7**, *Pt* 3, 299–316 (*Sept.*, 1954).

A variational method is developed which is applicable to waves whose field components are given in terms of one scalar potential. The conditions for the existence of pure *TE* or pure *TM* waves in such a waveguide are also considered. A.

538.566

398. Propagation of electromagnetic waves in cylindrical wave-guides with imperfectly conducting walls. V. M. PAPADOPOULOS. *Quart. J. Mech. appl. Math.*, **7**, *Pt* 3, 326–34 (*Sept.*, 1954).

The effect on the propagation is calculated by a perturbation method using approximate boundary conditions at the walls. The cross-section of the guide is arbitrary. In cases where a particular type of degeneracy occurs in the ideal guide, the introduction of imperfectly conducting walls removes the degeneracy; in such cases definite linear combinations of E and H modes are propagated with definite propagation constants. This type of degeneracy occurs in rectangular waveguides. It follows that the power-loss method of calculating the attenuation constant, is not correct in these cases. The perturbation method gives not only the attenuation constant for each combination of modes, but also the value of the phase velocity, and the corresponding field components. A.

538.566 : 621.396.674.3

399. Radiation from a point dipole located at the tip of a prolate spheroid. E. C. HATCHER, JR AND A. LEITNER. *J. appl. Phys.*, **25**, *No.* 10, 1250–3 (*Oct.*, 1954).

The radiation patterns of prolate spheroidal conductors, excited by an electric dipole in its tip, are calculated, for a number of spheroids of varying thickness, the wavelengths being equal to roughly π, $\pi/2$, and $\pi/3$ times their major axes. A.

538.566.2

400. Coupled wave equations for inhomogeneous anisotropic media. K. SUCHY. *Z. Naturforsch.*, **9a**, *No.* 7–8, 630–6 (*July–Aug.*, 1954) In German.

A special system of coordinates has been introduced for the calculation of electromagnetic wave propagation in an inhomogeneous, anisotropic medium. One of the coordinate axes is parallel to the wave normal, while the other two are defined by the relation between the vectors $\mathbf{E}$ and $\tilde{\mathbf{D}}$. It is shown that, under certain conditions, the coupling terms in these equations can be neglected. Z. F. WOJNAR

538.566.3

401. Polarization of radio waves reflected from the ionosphere. B. LANDMARK. Note in *J. atmos. terrest. Phys.*, **2**, *No.* 4, 254–5 (1952).

Vertical incidence measurements at Oslo and Tromso indicate that the third magneto-ionic component is polarized in the same way as the ordinary component. The axis ratio of the polarization ellipse decreases markedly at the onset of a magnetic storm, and also shows positive correlation with simultaneous absorption measurements. These effects may be explained as due to resplitting of the *o*-wave into *o*- and *x*-components during passage through the lower part of the ionosphere. G. M. BROWN

538.566.3

402. On certain questions in the theory of the propagation of a radio wave in the ionosphere in connection with their incorrect treatment by V. N. Kessenikh. V. L. GINZBURG. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4 (10) 498–508 (1953) In Russian.

A discussion of mistakes in V. N. Kessenikh's textbook *The propagation of a radio wave* (1952), under the headings: (1) The question of the effective field ($E = E_0$ or $E = E_0 + (4\pi/3)P$?); (2) The reflection of a wave from an ionizing layer; (3) The influence of the earth's magnetic field and the effect of the multiplication of reflected radio signals. W. J. SWIATECKI

538.566.3

403. Effect of thickness of the ionospheric layer on the multiple splitting and scattering of radio waves. S. S. BANERJEE AND D. K. BANERJEE. Letter in *J. sci. industr. Res.*, **13 B**, *No.* 8, 587–8 (*Aug.*, 1954).

Triple and quadruple splitting of ionospheric echoes when the vertical gradient of ionization is sharp have been observed on vertical incidence from the E layer (only in the presence of strong E_s) and F layer (around sunset). It has been verified that multiple

splitting only occurs when the layer is thin (semi-thickness $y_m \sim 35$ km), whereas scattering occurs when the layer thickness is large ($y_m \sim 105$ km).

G. M. BROWN

538.566.3 : 621.396.11

404. Ionospheric absorption at vertical and oblique incidence. G. McK. Allcock. *Proc. Instn Elect. Engrs III*, **101**, 360–6 (*Nov.*, 1954).

For abstract, see Abstr. 6746 (1954).

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

405. Solid state physics. H. Pick. *Naturwissenschaften*, **41**, *No.* 15, 346–54 (1954) In German.

A review of the following topics: Types of solids and binding mechanisms, lattice defects (electrical, chemical, structural), experimental investigations (hardness, diffusion, fluorescence, phosphorescence, semiconductivity, photoconductivity, photochemistry). 24 references.

E. P. WOHLFARTH

539.11

406. A quantum mechanical interpretation of radiationless electron transitions in solids. A. Haug. *Z. Phys.*, **138**, *No.* 5, 529–49 (1954) In German.

The transitions are considered to be due to a series of single phonon processes. Such a cascade process is possible if the energy band structure is modified by the presence of localized energy levels corresponding to the excited states of the electrons. The transition probability of the process is calculated.

E. P. WOHLFARTH

539.11

407. On intermolecular forces and crystal structures of rare gases. L. Jansen and J. M. Dawson. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1619–20 (*Sept.*, 1954).

Extension of the calculations of Kihara and Koba [Abstr. 7446 (1952)] to include the effect of zero-point energy does not affect their conclusion that, for all values of s in a Lennard-Jones (s, 6) potential, the hexagonal close-packed lattice should be more stable than the face-centred cubic lattice for the rare gases, in contradiction with experiment, except for He.

J. HAWGOOD

539.11

408. Electronic structure of primary solid solutions in metals. J. Friedel. *Advances in Phys.*, **3**, *No.* 12, 446–507 (*Oct.*, 1954).

A general review of the methods of calculating effects of impurities in metallic crystals. The distinction between bound and extended states is made clear, and self-consistent solutions and the implied screening of the Coulomb field dealt with in general terms. The molecular orbital method is discussed in detail, and band structure, density of states, ferromagnetics, solution energies, and changes in optical absorption edge in dilute alloys dealt with. Better degrees of approximation are used to discuss charge distribution, density of states and Hume–Rothery rules. The atomic orbital method is used to discuss magnetic susceptibility, energies of solution, and the fine structure of X-ray and optical absorption edges. Some critical discussion of the models is added, and an appendix treats effects attributable to the size factor.

W. M. LOMER

539.11

409. Spin-orbit coupling in band theory—character tables for some "double" space groups. R. J. Elliott. *Phys. Rev.*, **96**, *No.* 2, 280–7 (*Oct.* 15, 1954).

To take account of the electron spin in band theory, a method is outlined which allows character tables to be constructed for the double space groups of the simple, face-centred, and body-centred cubic, diamond, and hexagonal close packed lattices. The effects of time reversal are also considered. Particular attention is given to the splitting of otherwise degenerate bands by the spin-orbit coupling.

A.

539.11 : 532.7

410. Electronic structure of disordered one-dimensional chains. R. Landauer and J. C. Helland. *J. chem. Phys.*, **22**, *No.* 10, 1655–65 (*Oct.*, 1954).

The positions of the electronic levels in a variety of finite one-dimensional models of disordered alloys and of liquids have been evaluated numerically over a wide range of energies. The disordered alloys consist of two types of potential wells thrown together in a random sequence, but in equal proportions. In the disordered case the tightly bound states give rise to narrow bands in which the distribution of states cannot be described by a smooth function. The distribution of states can be interpreted in terms of an approximation in which each electron is confined to its own group of adjacent identical atoms. At high energy levels the disordered alloys obey perturbation theory, at least in a qualitative fashion, and the ordered alloy differs from the disordered one because of the effect of Bragg reflections from the superlattice. At high energies the distribution of states can be described by a reasonably smooth density function. Between the high energy range and the tightly bound levels, in some of the cases a transition region occurs, in which the levels are distributed irregularly, but without well-defined gaps and without being susceptible to the simple explanation of localized states. The total number of states (not counting the two spin possibilities as separate states) up to a well-pronounced energy gap is always an integral multiple of one-half the total number of atoms in the chain. The liquids consist of a series of identical wells separated by a variable well-to-well space. In a liquid the forbidden energy ranges are either smaller than in the strictly periodic crystal, or else nonexistent. The extent to which an energy gap in the strictly periodic crystal will be affected by the introduction of dispersion in the spacing depends on the original gap width as well as on the sensitivity of the gap position, in the strictly periodic case, to uniform dilations. In both the liquid cases and the disordered alloy models a distinction must be made between energy ranges in which the density of states is very low and ranges in which it is strictly zero.

A.

539.11 : 548.7

411. On the energy scheme of the system: electron–vibrating lattice. H. HAKEN. *Z. Phys.*, **139**, *No.* 1, 66–87 (1954) In German.

The band structure is deduced from the general character of the solutions of the Schrödinger eqn. for the above system. An exact one-dimensional calculation is carried out for a particular interaction (product of a linear function of the creation and annihilation operators of phonons, and of the sum of δ functions centred on the lattice points). The results are compared with those obtained from a variational method, and from the method of apparent mass. Renormalization of the velocity of sound and the instability of the lattice are also discussed.

F. ANSBACHER

539.11 : 548.7

Investigations in the electron theory of crystals. *See Abstr.* 622

MOLECULES 539.13

539.13

412. Influence of permanent multipole interactions on vibrational deactivation in molecular collisions. F. W. DE WETTE AND Z. I. SLAWSKY. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1620 (*Sept.*, 1954).

Usual treatments of collision deactivation neglect the effect of long-range adiabatic forces, but in fact these have two effects, changing the relative motion of the molecules and perturbing their internal states. Numerical calculations show that in the configuration in which the molecules attract one another, the deactivation probability is increased, by a factor 4 for dipole–dipole interactions in HCl, and by a factor 2 for quadrupole–quadrupole interactions in CO. J. HAWGOOD

539.13

413. Deviations from additivity of the intermolecular field at high densities. L. JANSEN AND Z. I. SLAWSKY. *J. chem. Phys.*, **22**, *No.* 10, 1701–4 (*Oct.*, 1954).

The intermolecular field of an assembly of neutral atoms or molecules is usually assumed to be additive with respect to isolated pairs. Nonadditive effects have been calculated in the first-order forces by Rosen and in the second-order forces by Axilrod and Teller. For the evaluation of second-order forces between two molecules at high densities the zero-order wave-function must be made antisymmetric with respect to nearest neighbours. It is shown that this correction results in a decrease of the second-order forces compared to an isolated pair of molecules, and may be interpreted as a screening effect. The method is based on the model of the caged atom or molecule. A.

539.13 : 539.152.2

414. Proton magnetic resonance and structure of ammonium hydroxide. H. S. GUTOWSKY AND S. FUJIWARA. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1782–3 (*Oct.*, 1954).

The proton resonance absorption of NH_3 solutions in H_2O is a single peak less than 1 millioersted wide at all concentrations indicating proton exchange between NH_3 and H_2O faster than 10^3 times per sec. The position varies linearly with concentration and is intermediate between that for H_2O and liquid NH_3.

D. H. WHIFFEN

539.13

415. The influence of symmetry in the theory of oscillations of polyatomic molecules. L. S. MAYANTS. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4 (10) 393–406 (1953) In Russian.

A revised version of the method given in Abstr. 5220 (1952) for the exploitation of simplifications resulting from the presence of symmetries when determining the normal oscillations of dynamical systems (especially molecules). Algebraically the problem can be stated as the diagonalization of an n-dimensional matrix (n = number of degrees of freedom). The presence of symmetries leads to the reduction to a step matrix consisting of square matrices along the diagonal, the reduction being defined by the type of symmetry present and independent of the actual values of the matrix elements. The carrying through of this reduction is given explicitly, without the use of group theory, first when there is one element of symmetry and then for the general case. The method is illustrated for the tetrahedral CH_4 and the pentagonal C_5H_{10} molecules.

W. J. SWIATECKI

539.132/.133

416. A quantum-mechanical treatment of the symmetrical hydrogen bridge. A. N. BAKER, JR. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1625–6 (*Sept.*, 1954).

Perturbation calculation of the variation with O–O distance ($2d$) of the fundamental vibration frequency of the H atom in an O–H . . . O bridge. Two superposed OH Morse functions are used as the potential, and wave-functions of the OH molecule as zero-order functions. The theory predicts a pair of comparable intensity bands with separation increasing rapidly with decreasing d. Only one band has been observed; for this the first-order theory predicts the correct trend as d changes, but predicts shifts due to H bonding about 25% too large. J. HAWGOOD

539.132

417. Nitrogen electronegativity correction in free electron network theory. S. BASU. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1625 (*Sept.*, 1954).

See Abstr. 9464 (1954). Correction is made by assuming a potential well in the uniform potential field of a carbon chain containing a nitrogen in conjugation. This is experimentally verified by comparing the calculated and observed absorption wavelengths of a diphenyl polymethene dye and an Indemine dye, the latter being obtained from the former by replacement of a central $=CH-$ group by a $=N-$ group. G. I. W. LLEWELYN

539.132 : 535.347

418. Dichroism of the crystal of dicyclopentadienyl–iron. S. YAMADA, A. NAKAHARA AND R. TSUCHIDA. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1620–1 (*Sept.*, 1954).

Experimental results indicate that the iron is firmly linked to the cyclopentadienyl rings, π-electrons being involved, but that the π-electron system differs

from those in complexes of the usual type as well as from aromatic systems. This may be explained by the formation of co-ordinate bonds with the iron.

J. HAWGOOD

539.132

419. Substituted methanes. XXIV. Potential constants for CCl_2F_2. J. M. DOWLING. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1789 (*Oct.*, 1954).

For Pt XX, see Abstr. 8483 (1954). Previous Raman and infrared data on gaseous CCl_2F_2 suggest either 446 K or 473 K for the b_2 fundamental. Thermodynamic arguments suggested 446 K. Here a normal coordinate treatment is carried out with a potential energy function containing all second degree terms. Potential constants were taken from related carbon halides. The calculations also suggest the 446 K band as b_2 fundamental, but do not completely rule out the other possibility. All wave numbers calculated agree well with experimental values.

A. J. TAYLOR

539.132 : 535.343.4–14

Centrifugal stretching constants of methyl halides. *See Abstr.* 190

539.132

420. Correlation of vibrations of a molecule with those of its parts: Calculation of some vibration frequencies of mono-substituted benzenes. S. N. GARG. *J. sci. Res. Banaras Hindu Univ.*, **4**, 83–94 (1953–54; *publ. July*, 1954).

A method of correlating the vibrations of a molecule to those of its separated parts is discussed. How some of the non-genuine vibrations of the separated parts combine to produce some genuine vibrations of the resultant molecule is illustrated in detail. Mono-substituted benzenes (substituent being an atom or a group of atoms) are dealt with in this way, and, with the help of the Teller–Redlich product rule, formulae (containing the mass of the substituent as the only variable) have been derived to calculate a few frequencies of these molecules. In general, the agreement is satisfactory. Behaviour of the other (remaining) frequencies of benzene on substitution is also shown.

A.

539.132

421. Determination and interpretation of the low frequencies of the infrared absorption of dimethylether; application to the calculation of thermodynamic functions. A. HADNI. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 4, 349–51 (*July* 26, 1954) In French.

Two new frequencies have been found: 412·2 cm^{-1} (deformation C–O–C) and 270 cm^{-1} (torsion CH_3) and the exact positions of the vibrations of CO and the rotations of CH_3 are given. Specific heat and entropy calculated with the new values agree with the calorimetric values.

C. TURNER

539.132

422. Vibrational transition probabilities of diatomic molecules. III. P. A. FRASER. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 939–41 (*Oct.*, 1954).

A term correcting an approximate analytical method [Abstr. 1525–6 (1954)] for the evaluation of vibrational overlap integrals is derived and applied to bands of the B–X system of CN.

R. F. BARROW

539.132

423. Rotational constants of GeH_3D and $GeHD_3$. L. P. LINDEMAN AND M. K. WILSON. *J. chem. Phys.*, **22**, *No.* 10, 1723–7 (*Oct.*, 1954).

The analysis of the rotational structure of the Ge—D stretching fundamental of GeH_3D yields the following values: $B'' = 1{\cdot}95_7$, $B'' - B' = 0{\cdot}014_2 \pm 0{\cdot}0017$, $\nu_0 = 1520{\cdot}4 \pm 0{\cdot}2\ cm^{-1}$. A similar analysis of the Ge—H stretching mode in GeD_3H yields for this molecule: $B'' = 1{\cdot}66_5$, $B'' - B' = 0{\cdot}012_8$, $\nu_0 = 2112{\cdot}4 \pm 0{\cdot}2\ cm^{-1}$. The germanium-hydrogen distance obtained under the assumption that it is unchanged by isotopic substitution is $1{\cdot}52_9 \pm 0{\cdot}003$ and $1{\cdot}52_5 \pm 0{\cdot}005$ in GeH_3D and $GeHD_3$, respectively.

A.

539.132

424. Theory of the interaction of hindered internal rotation with over-all rotations. I. Symmetric rotors: methyl silane. D. KIVELSON. *J. chem. Phys.*, **22**, *No.* 10, 1733–9 (*Oct.*, 1954).

An approximate theory of the interactions of hindered internal rotation with over-all rotations of symmetric rotors is given. This treatment considers the interdependence of hindered internal rotation and vibrations and their effect upon the rotational energy levels. The resulting expression for the frequencies of $\Delta K = 0$, $\Delta J = 1$ transitions is

$$\nu = 2J[B_v + F_v(m|1 - \cos 3\theta|m) + G_v(m|\Pi_z^2|m) + L_vK(m|\Pi_z|m)],$$

where B_v, F_v, G_v, and L_v are constants independent of the rotational quantum numbers, m represents the basis that diagonalizes the Hamiltonian corresponding to pure internal rotation, Π_z is the internal angular momentum operator, and θ is the angle of internal rotation. Procedures for evaluating $(m|1 - \cos 3\theta|m)$ and $(m|\Pi_z^n|m)$ in terms of a parameter α are given. This theory has been applied to the $J = 0 \rightarrow 1$ transitions of methyl silane. The parameters B_v, F_v, G_v and α were obtained empirically and were then used to calculate frequencies. The agreement between observed and calculated values was quite good. Furthermore, the anomalous ordering of the lines observed by Lide and Coles is explained by these calculations. Assuming a cosine potential, the barrier height V_0 is proportional to the parameter α. The value of V_0 was set at 558 $cm^{-1} \pm 17\ cm^{-1}$. The constant B_v, which is the rotational constant in the ground torsional state for the limiting case of $V_0 = 0$, is 10985·79 Mc/s and 9636·50 Mc/s for CH_3SiH_3 and CH_3SiD_3, respectively.

A.

539.132

425. Distribution of kinetic and potential energy in vibrating molecules. W. J. TAYLOR. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1780 (*Oct.*, 1954).

The elements of the matrix connecting the normal coordinates with the internal coordinates (bond lengths and angles) of a molecule are not invariant to the units used in the latter. It has been suggested that the distribution of potential energy among the normal modes be used as a criterion of the form of the normal modes. It is here pointed out that both potential and kinetic energy should be considered, and it is shown that when both these contributions to the energy of a mode come predominantly from the

same internal coordinate, the corresponding normal frequency is nearly equal to that of the uncoupled internal coordinate. A. J. TAYLOR

539.132 : 541.632

426. Further evidence for the existence of the *gauche*-form of 1,2-dichloroethane. S.-I. MIZUSHIMA, I. NAKAGAWA, I. ICHISIMA AND T. MIYAZAWA. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1614 (*Sept.*, 1954).

The normal frequencies for all rotational isomers of 1, 2-dichloroethane have been calculated [Abstr. 3497 (1953), 3326 (1954)]. Two strong absorption bands (880, 941 cm^{-1}) due to the CH_2 rocking vibration of the less stable isomer have been observed, which agrees with theory for the *gauche* form (C_2), but not for the *cis* form (C_{2v}), for which the A_2 vibration (937 cm^{-1}) is forbidden, so that only one band (742 cm^{-1}) would be observed if the less stable form were *cis*. Thus *gauche* and *trans* (the stable form) are the isomers existing. J. HAWGOOD

539.132

427. Excitation energies of Li_2-molecule. A. RAHMAN. *Physica*, **20**, *No.* 9, 623–32 (*Sept.*, 1954).

Li_2 is treated as a two-electron problem with the atomic *K*-shells merged into the nuclei. The molecular orbitals are built out of $2s$, $2p_{x,y,z}$ atomic orbitals centred on each nucleus, the exponent in the $2s$ and $2p$ functions being the same. The excitation energies for the transitions $^1\Sigma_u^+ - {}^1\Sigma_g^+$, $^1\Pi_u - {}^1\Sigma_g^+$ as calculated by the usual anti-symmetrized molecular orbitals, linear combination of atomic orbitals (ASMO, LCAO) theory are given first and compared with experimental values; as expected there is wide discrepancy, the position being worse at infinite internuclear separation than in the neighbourhood of the equilibrium distance. Moffitt's idea of "Atoms in Molecules" is applied then to this model for Li_2. It is found that on this simplified model the application of the method leads to quite wrong values for the excitation energies when all the configurations used in the ASMO, LCAO calculation are included in the scheme. It is found that on leaving out the purely ionic configurations, i.e., the configurations representing Li^+ and Li^- as interacting units, the results are as satisfactory as could be desired in the circumstances, the discrepancy between calculated and experimental values being always less than 0·3 eV. An unobserved higher $^1\Pi_u$ state is investigated showing a minimum of energy. A.

539.132

428. Magnetic dipolar interactions in MnO and in ferrites. J. I. KAPLAN. *J. chem. Phys.*, **22**, *No.* 10, 1709–12 (*Oct.*, 1954).

The magnetic dipole energies of MnO and of the normal and inverse spinel structures are calculated. It is found that with this interaction alone MnO would have its direction of spin alignment in a (111) plane, in contrast to the experimentally found [100]. The addition of a nearest-neighbour quadrupole interaction is suggested as a means of making the [100] direction preferred. The normal and the inverse spinel structures are found to have zero magnetic dipole energies. A.

539.132

429. Zeeman effects in the chlorine nuclear quadrupole resonance in sodium chlorate. YU TING, E. R. MANRING AND D. WILLIAMS. *Phys. Rev.*, **96**, *No.* 2, 408–14 (*Oct.* 15, 1954).

The Zeeman splitting of Cl^{35} nuclear quadrupole resonance lines in a single crystal of sodium chlorate has been studied in a magnetic field sufficiently large to permit detailed investigation of individual Zeeman components for various orientations of the crystal in the applied magnetic field. The observed patterns are in agreement with theoretical predictions based on a Hamiltonian involving an interaction of the nuclear electric quadrupole moment with a crystalline field having axial symmetry and the interaction of the nuclear magnetic moment with the applied magnetic field. The quadrupole interaction term e^2Qq was found to be $58{\cdot}806 \pm 0{\cdot}002$ Mc/s and the effective nuclear magnetic moment was found to be $0{\cdot}8215 \pm 0{\cdot}0001$ nuclear magnetons. An upper limit for the electric asymmetry parameter η was found to be 0·0012. The intensity variations of individual Zeeman components for different orientations of the crystal relative to the magnetic field were studied. The line width of individual Zeeman components was of the order of 900 c/s. A.

539.132

430. Complex hyperfine structures in microwave spectra of covalent iridium compounds. J. H. E. GRIFFITHS AND J. OWEN. *Proc. Roy. Soc. A*, **226**, 96–112 (*Oct.* 21, 1954).

Magnetic resonance spectra are described for two compounds containing covalently bound $[IrCl_6]^{2-}$ complexes and one containing $[IrBr_6]^{2-}$, and the results are analyzed using the π-bonding theory developed by Stevens. The spectra show hyperfine structure lines arising from interaction of the magnetic electrons both with the Ir nucleus ($I = \frac{3}{2}$) and with the Cl ($I = \frac{3}{2}$) or Br ($I = \frac{3}{2}$) nuclei, and different examples are discussed where the numbers of resolved lines are 4, 8, 13, 16 and 22. It is shown how these structures, the *g*-values and the difference between the spectra in $[IrCl_6]^{2-}$ and $[IrBr_6]^{2-}$ are all consistent with the hypothesis that the magnetic electrons move partly in *d*-orbits round the central Ir nucleus and partly in p_π-orbits round the outer halogen nuclei of the complex. A.

539.132

431. Hybridization, equilibrium angle and normal vibrations of H_2O and related molecules. K. ARTMANN. *Z. Phys.*, **138**, *No.* 5, 640–57 (1954) In German.

As the H–H distance is smaller in H_2O than in H_2S, one would expect a larger departure from $\pi/2$ for H_2O than for H_2S for the angle in the molecule, if pure *p* bonds only were considered. This is indeed found, but there is poor quantitative agreement. If hybridization is taken into account, the hybridization parameter μ must increase from H_2Se to H_2O, but energy considerations would suggest the opposite. This problem was investigated; the molecular energy was expressed in terms of geometrical parameters, so that differentiation could be carried out and the angle as well as the normal vibrations calculated. These last are not very much affected by hybridization. It was also found that, although hybridization of the two binding orbitals tends to increase the molecular angle, this is partly compensated by the hybridization with the orbital of the lone pair of electrons; in the

case of H_2S and H_2Se this influence is so strong that it overcompensates the spreading tendency. A detailed report of the calculations and results is given.
A. J. TAYLOR

539.132

432. Delta potential function model for electronic energies in molecules. A. A. FROST. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1613 (*Sept.*, 1954).

Electrons are restricted to motion along a one-dimensional path, and attractions to nuclei represented by δ-functions. For the 1*s* state of a hydrogen-like atom, the effects of these two factors compensate each other, giving correct E and $\psi(x)$. For H_2^+, and polyatomic systems in general, LCAO gives the exact solution for this potential; the E–R curve obtained for H_2^+ is of the correct form. Ionization energies can be calculated.
J. HAWGOOD

539.132

433. Use of the idea of shell in the study of chemical bonds. H. BRION, R. DAUDEL AND S. ODIOT. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 10, 644–6 (*Sept.* 6, 1954) In French.

A distinction is made between inner atomic shells of electrons and shells of binding electrons. Li_2 is taken as an example. Monoelectronic Slater functions are used for the determination of the atomic wave-functions; for the molecule the functions developed by Coulson and Duncanson were used. Three shells can be distinguished, two of which resemble the K shells of free atoms, the third one representing the binding electrons. There is only 3% delocalization between the shells.
A. J. TAYLOR

539.132

434. Free electron model for tropolone. S. BASU. Letter in *J. chem. Phys.*, **22,** *No.* 10, 1776 (*Oct.*, 1954).

Calculations based on the free-electron model for the π-electrons give good agreement with experiment for the principal absorption maximum of the tropolone anion. From calculation of π-electron energies of quinonoid transition states it is predicted that electrophilic substitution is most likely to occur at the para-position; this agrees with MO predictions.
A. J. TAYLOR

539.132 : 518.5

435. The application of electronic digital computers to molecular orbital problems. I. The calculation of bond lengths in aromatic hydrocarbons. H. O. PRITCHARD AND F. H. SUMNER. *Proc. Roy. Soc. A,* **226,** 128–40 (*Oct.* 21, 1954).

The Manchester computer has been programmed for the complete solution of molecular orbital problems not including overlap. The technique is applied to the calculation of bond lengths in eight aromatic hydrocarbons using a self-consistent molecular orbital approximation, and the results are compared with existing experimental values.
A.

539.132 : 541.57

436. Note on the hybrids in the nontetrahedral carbon atom. M. MASHIMA. Letter in *J. chem. Phys.*, **22,** *No.* 10, 1785–6 (*Oct.*, 1954).

In calculations on bent C–C bonds in strained hydrocarbons, Kilpatrick and Spitzer [Abstr. 2984 (1946)] used the numerical value of the orbital in the C–C direction as the bond strength. If, instead, is used the maximum, as hybridization is varied, of the greatest projection of the orbital along the C–C direction, a greater bond strength results, and the agreement with experiment of the HCH angle is improved. Compare Abstr. 2304 (1947), 2038 (1949).
J. HAWGOOD

539.133

437. Classical model for rotational magnetic moments in molecules. C. K. JEN. *Amer. J. Phys.*, **22,** *No.* 8, 553–8 (*Nov.*, 1954).

The classical model for rotational magnetic moments in molecules is useful for elucidating physical description, although it must give way to quantum mechanics for fundamental formulation. A powerful method of approach, first applied to the problem by Wick, is afforded by the generalized theorem of Larmor, which is here derived from the equations of motion for a rotating molecule placed in a magnetic field. It is shown that the electronic motion relative to the nuclear frame must be perturbed by the Coriolis torque as a consequence of molecular rotation. The rotational magnetic moment of the molecular electrons can be considered to consist of two parts, one due to "rigid" motion together with the nuclear frame and the other to "nonrigid" motion, which is equivalent to that created by a magnetic field in a nonrotating molecule according to the relation $H = -\omega/\gamma$.
A.

539.133 : 535.343.4–14

Microwave spectrum and properties of vinylene carbonate. *See Abstr.* 192

539.133 : 535.343.4–14

Microwave spectrum of formic acid. *See Abstr.* 191

539.133 : 541.653

The shape dependence of the optical anistropy of long chain molecules. *See Abstr.* 611

539.133 : 548.737

438. Structures of molecules and crystals of fluorocarbons. C. W. BUNN AND E. R. HOWELLS. *Nature* [*London*] **174,** 549–51 (*Sept.* 18, 1954).

ATOMS . NUCLEUS . ISOTOPES 539.15

539.152.1

439. Recent progress in nuclear physics. A. BORSELLINO. *Nuovo Cimento Suppl.*, **12,** *No.* 1, 26–30 (1954) In Italian.

A review of a group of problems in nuclear spectroscopy.
L. PINCHERLE

539.152.1

440. On the repulsive interaction between nucleons. G. SZAMOSI. Note in *Naturwissenschaften,* **41,** *No.* 16, 369 (1954) In German.

The generalizations of the formulae of Fermi statistics when each nucleon is assumed to occupy a finite volume are given, and the implications for saturation phenomena and the properties of excited states are discussed.
E. H. SONDHEIMER

539.152.1

441. A new method for determining the levels of Be^8. H. Glättli, E. Loeppe and P. Scherrer. *Nuovo Cimento*, **12**, *No.* 2, 174–90 (*Aug.*, 1954) In German.

Makes use of the decay of excited C^{12} nuclei into 3 α-particles. From the dynamics of the C^{12} decay it was found that for a given excitation energy the energy of the Be^8 levels can be determined without the necessity of measuring the energies of the individual α-particles. The spin of the Be^8 levels can be obtained from angular correlation measurements on the reaction $B^{11}(p, \alpha)Be^{8*}$. J. HUGHES

539.152.1

442. Gyromagnetic ratio of 10^{-8}-second Ta^{181m}. S. Raboy and V. E. Krohn. Letter in *Phys. Rev.*, **95**, *No.* 6, 1689–90 (*Sept.* 15, 1954).

By studying the angular correlation pattern for the 132–480 keV cascade as function of a magnetic field the value of g was found to be $1{\cdot}20 \pm 0{\cdot}12$ nuclear units. W. J. SWIATECKI

539.152.1

443. On the level scheme of Np^{237*}. J. Milsted, S. Rosenblum and M. Valadares. *C.R. Acad. Sci [Paris]* **239**, *No.* 12, 700–2 (*Sept.* 20, 1954) In French.

The multipole character of the 6 γ-rays excited during the α-decay of Am^{241} [Abstr. 10473 (1954)] is inferred from internal conversion coefficient measurements and other data. Spins are assigned to 3 of the 5 levels involved and it is concluded that these are rotational states of the nucleus. M. A. GRACE

539.152.1

444. Energy levels of the O^{16} nucleus. D. M. Dennison. *Phys. Rev.*, **96**, *No.* 2, 378–80 (*Oct.* 15, 1954).

A discussion of the energy levels of the O^{16} nucleus is given on the basis of an α-particle model. A considerable number of excited states are calculated under the assumption that the higher order rotation-vibration interactions can be neglected. The positions of the levels depend upon four parameters, three of which relate to the potential while the fourth measures the effective radius of the nucleus. Two possible correlations between the observed and predicted levels are made. The first identification, which appears to be somewhat the more satisfactory, succeeds in correlating sixteen levels in the range from 0 to 13·25 MeV with regard to their positions, angular momenta and parities. Five levels are predicted in the range from 9·5 to 13·8 MeV which do not appear to have been observed. However, three levels have been found in this range but as yet their spins and parities have not been determined and no attempt has been made to assign them. The effective radius of the O^{16} nucleus is found to be $2{\cdot}5 \times 10^{-13}$ cm which is somewhat smaller than might have been expected. A.

539.152.1

445. Some properties of nuclear normal modes. I. Bloch and Y.-C. Hsieh. *Phys. Rev.*, **96**, *No.* 2, 382–5 (*Oct.* 15, 1954).

Energy levels and antisymmetric eigenfunctions are calculated, with the aid of normal coordinates, for a nuclear Hamiltonian containing inter-nucleon potentials of the Hooke's law type. Such a nuclear model exhibits the same shell structure as do the same nucleons moving without interaction in a common harmonic-oscillator central field. Modifications in the Hamiltonian—use of force parameters which depend on A, cutting off of forces at finite range, inclusion of spin-orbit forces—are discussed in connection with shell structure and the nuclear photoeffect. A.

539.152.1

446. Coulomb excitation process in the lighter odd-mass nuclei. G. M. Temmer and N. P. Heydenburg. *Phys. Rev.*, **96**, *No.* 2, 426–33 (*Oct.* 15, 1954).

The Coulomb excitation functions for thin targets of F^{19}, Na^{23}, Ti^{47}, Mn^{55} and Ge^{73}, and for thick targets of V^{51} and Fe^{57}, with alpha particles up to 3·5 MeV; the energy levels excited in these nuclei are at 113 and 196 keV, 446 keV, 160 keV, 128 keV, 68 keV, 320 keV and 137 keV, respectively. The de-excitation γ-rays from these levels to the ground states were detected except for Fe^{57}, where a 123-keV γ-ray is predominantly emitted. In addition the 182-keV level has been excited in Zn^{67}, whose de-excitation takes place partly by cascade through the 92 keV first excited state. In the cases of F^{19} and Na^{23} it was possible to compare directly the relative contributions of Coulomb excitation and compound nucleus formation by means of the $(\alpha,p\gamma)$ reactions taking place via the same compound nuclei. In all cases the excitation curves are in fair agreement with the theoretical $E2$ curves at the lower energies, but show definite deviations in the direction of too much excitation at the higher energies, pointing to some resonant compound-inelastic contribution as well as possible penetration effects not accounted for by the classical theory. The transition probabilities of all transitions are about one-tenth of those in the rate earth region. A.

539.152.1

447. Pairing effects in Coulomb energies and the radii of mirror nuclei. B. C. Carlson and I. Talmi. *Phys. Rev.*, **96**, *No.* 2, 436–44 (*Oct.* 15, 1954).

The Coulomb energy difference between the nuclei of a mirror pair exhibits an odd-even alternation with Z that is presumed to reflect the well-known pairing property of the short-range nuclear forces. By taking second differences of Coulomb energy (differences between successive mirror pairs), the alternation is seen to continue to at least $Z = 15$, and additional irregularities appear that may be shell-structure effects. The analysis of Feenberg and Goertzel is discussed from the point of view of the shell model, and the pairing of spins is extended to the spherically symmetric pairing characteristic of the state of lowest seniority. A harmonic oscillator model with jj coupling is used to calculate the Coulomb energy, including exchange effects, in the state of lowest proton seniority. The single parameter of the model is determined by comparison with experimental data and remains constant to $\pm 1{\cdot}5\%$ through the $p_{1/2}$ and $d_{5/2}$ shells. The r.m.s. radius of the nuclear charge distribution is calculated by the same model. Between C^{13} and Al^{27}, the equivalent r_0 decreases fairly smoothly from 1·34 to 1·20. For $A \leqslant 11$ the model is not satisfactory, and for $A \geqslant 31$ there are

some serious inconsistencies in the data. The most recent data indicate that r_0 may decrease to the range 1·1 to 1·15 for $A \simeq 39$. A.

539.152.1

448. Consistency of nuclear radii from electron scattering and Coulomb energy data. VACHASPATI AND S. M. SHAH. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 950–1 (*Oct.*, 1954).

For a charge distribution consisting of a negative point charge surrounded by a positive charge decreasing according to $r^{-1} \exp(-ar)$, an effective "Coulomb energy radius" is greater than a radius for scattering. W. J. SWIATECKI

539.152.2

449. On a universal scheme for the observation of the magnetic resonance of atomic nuclei. S. D. GVOZDOVER AND N. M. IEVSKAYA. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4(10), 435–40 (1953) In Russian.

In order to combine the advantages of the bridge-type and the 2-coil type magnetic resonance circuits (in which the final adjustment is achieved by balancing the bridge and by mechanical methods, respectively) a simple circuit was devised, consisting of a resistance, 3 fixed and 3 variable condensers, connected to the two coils surrounding the sample. The final balancing is achieved by tuning the circuit. The theory of the methods is given. Tests showed the method to work both for weak and strong high frequency fields, which makes possible the observation of the "inversion" of the vector of magnetization. [See Abstr. 7085 (1950)]. W. J. SWIATECKI

539.152.2

450. On the calculation of nuclear magnetic moments on the basis of $j-j$ coupling between protons and neutrons. I. A. VAĬSMAN. Letter in *Zh. éksper. teor. Fiz.*, **26**, *No.* 6, 754–6 (1954) In Russian.

A critique of Mizushima and Umesawa [Abstr. 8127 (1951), 2036 (1952)]. Unfavourable results of these authors are pointed out and for nuclei for which favourable results were obtained, other mechanisms are proposed. G. E. BROWN

539.152.2

451. Configuration mixing and magnetic moments of nuclei. A. ARIMA AND H. HORIE. Letter in *Progr. theor. Phys.*, **11**, *Nos.* 4–5, 509–11 (*April–May*, 1954).

Deviations from the Schmidt lines due to configuration mixing are calculated for more general cases than those considered by Blin-Stoyle [Abstr. 1568 (1954)]. Agreement with experimental values is good. P. T. MATTHEWS

539.152.2

452. Nuclear magnetic resonance in a rotating field. C. MANUS, G. BÉNÉ, P. DENIS, R. EXTERMANN AND R. MERCIER. *C.R. Acad. Sci.* [*Paris*] **238**, *No.* 5, 414–15 (*Aug.* 2, 1954) In French.

Proton resonance signals at 360 kc/s have been observed in a rotating magnetic field, both circular and elliptical. Four signals per cycle were obtained with the expected amplitude variation with the ratio of the longitudinal relaxation time to the field period and with the angle between the h.f. bobbin axis and the major axis of the ellipse. D. H. WHIFFEN

539.152.2

453. Bromine quadrupole spectra and Hammett's sigma values. P. J. BRAY. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1787–8 (*Oct.*, 1954).

539.153

454. On the question of the sequence of terms in the spectra of many-electron atoms. V. M. KLECHKOVSKIĬ. *Zh. éksper. teor. Fiz.*, **25**, *No.* 2 (8) 179–87 (1953) In Russian.

In previous works the author has shown that atomic levels are filled in order with electrons with increasing values of $n + l$, the principal and orbital quantum numbers, respectively. It is shown here that the sequence of excited levels near the ground level is ordered in a similar way. G. E. BROWN

539.153

455. Analytical one-electron wave functions in a multi-configurational approximation for atoms of the type of helium and beryllium. V. I KAVETSKIS AND A. P. YUTSIS. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 257–63 (1953) In Russian.

Configurations are formed from products of one-electron functions and the parameters are determined by a variational calculation. Results for energies are given for two- and three-configurational approximations. The configurational approximations in helium are $1s^2$–$2p^2$, $1s^2$–$2s^2$; for beryllium, $1s^22s^2$–$1s^22p^2$ and $1s^22s^2$–$1s^23d^2$. The same parameter is used in a given one-electron function in each configuration throughout a given approximate calculation. G. E. BROWN

539.153

456. Solution of the Fock equations for the beryllium atom in a two-configurational approximation. V. V. KIBARTAS AND A. P. YUTSIS. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 264–70 (1953) In Russian.

The configurations $1s^22s^2$–$1s^22p^2$ are employed to generalize the self-consistent field method. One-electron radial functions are employed which are (*a*) solutions of the Fock equations (in a one-configurational approximation); (*b*) solutions in the two-configurational approximation. The results are: "Fock" energy, −14·577; (*a*) −14·611; (*b*) −14·622; experiment, −14·666 in atomic units. G. E. BROWN

539.153

457. On the ground state of the mesonic atom. M. SUFFCZYŃSKI. Letter in *Nuovo Cimento*, **12**, *No.* 3, 455–6 (*Sept.*, 1954).

Numerical integration of the Dirac equation in a potential due to a charge $\rho(r) = (Ze/2a^3)\exp(-r/a)$ gives the ground state at $-10{\cdot}258 \pm 0{\cdot}003$ MeV for $a = 1{\cdot}865 \times 10^{-13}$ cm and $-10{\cdot}754 \pm 0{\cdot}004$MeV for $a = 1{\cdot}696 \times 10^{-13}$ cm. W. J. SWIATECKI

539.153

458. Tables of statistical electron distributions for atoms with degree of ionization zero to four and of the corresponding electrostatic potentials. L. H. THOMAS. *J. chem. Phys.*, **22**, *No.* 10, 1758–67 (*Oct.*, 1954).

The potential and electron density in statistical distributions for atoms according to Dirac's equation and Jensen's boundary conditions are given as functions of radial distance on a logarithmic scale for neutral atoms and for singly charged positive ions, at uniform interval of a parameter γ. A simple

interpolation only is required to obtain them for any particular atomic number. The values of the separate terms in the energy of the distribution are also given. Tables at a closer interval in radial distance and for positive ions up to charge four can be obtained. They are also available on punched cards. A.

539.153

459. Statistical atom with angular momentum. A. M. SESSLER AND H. M. FOLEY. *Phys. Rev.*, **96**, *No.* 2, 366–8 (*Oct.* 15, 1954).

By means of a variational principle, the method of Thomas and Fermi is extended, in a semiclassical manner, to atoms with a net total angular momentum. The resulting equation for the potential, which is valid for large angular momentum, is solved for small angular momentum, yielding approximate charge and current distributions for atoms in P and D states. Orbital magnetic hyperfine structure, and electric quadrupole h.f.s. are calculated as a function of atomic number, and it is shown that the first is in approximate agreement with experiment. A.

539.153

460. Influence of a magnetic field on the polarization of the radiation 2139 Å emitted in optical resonance by a zinc atom. M. SPITZER. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 12, 696–8 (*Sept.* 20, 1954) In French.

The polarizations at $\pm 45°$ to the excitation are calculated and it is verified that the dependence of the polarization on the magnetic field is given correctly by the calculated formula. G. E. BROWN

539.153

461. On the value of the lifetime of a state excited by an optical resonance. P. SOLEILLET. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 12, 698–700 (*Sept.* 20, 1954) In French.

The relation of the lifetime to the polarization of an atom in a magnetic field is considered theoretically (classically). G. E. BROWN

539.153.4

462. On the calculation of the Slater integrals. W. BINGEL. *Z. Naturforsch.*, **9a**, *No.* 7–8, 675–84 (*July–Aug.*); Erratum, *No.* 9, 807 (*Sept.*, 1954) In German.

Closed forms are given for the Slater integrals, $I(n,1)$, $F^k(n,1;n,1)$, and $G^k(n,1;n,1)$ for any value of the quantum numbers n . 1, (but n integral for G^k and F^k). The values derived from these results for a number of isoelectronic sequences in the 1st and 2nd periods of the periodic table are compared with the experimental values. J. HUGHES

539.153.4

463. Analysis of the three parameter wave function of Hylleraas for the He I ground state in terms of central field wave functions. L. C. GREEN, M. M. MULDER, P. C. MILNER, M. N. LEWIS, J. W. WOLL, JR, E. K. KOLCHIN AND D. MACE. *Phys. Rev.*, **96**, *No.* 2, 319–25 (*Oct.* 15, 1954).

A study of configuration interaction in the ground state of He I has been carried through by expanding the various angular components of the three-parameter wave-function of Hylleraas in orthonormal sets of functions. The different sets have been constructed from symmetrized products of hydrogenic wave-functions with different values of the parameter Z. The importance of the various configurations for $Z = 2$ is commented upon at some length. Configurations involving a free electron are shown to make surprisingly large contributions. The changing importance of the various components with changing Z is illustrated. In particular, the minimum with respect to Z of the contribution of configurations containing a free electron is pointed out. The implications of the results of these expansions for attempts to obtain wave-functions for both normal and excited states of two-electron systems by the minimum principle from linear combinations of products of hydrogenic functions of the proper symmetry are discussed. A.

539.153.4 : 537.533.74

464. On the theory of the collision of electrons with hydrogen atoms. G. F. DRUKAREV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 2(8) 129–38 (1953) In Russian.

The procedure for treating exchange effects outlined by Mott and Massey is criticized in that only outgoing waves are chosen at one point in the calculation with exchange functions, whereas going by way of Volterra integral equations this choice seems to be impossible. A procedure of generalizing Fock's treatment of exchange effects to atomic collisions is outlined. The wave-function is expressed as an antisymmetrized sum over α of products of $\psi_\alpha(r_i)$, the eigensolution of the nucleus plus one electron system (in a bound continuum state) and $f_\alpha(r_j)$ the eigensolution of the nucleus plus incident electron system. The interaction between the electrons couples various terms of this sum. The dependence on α can be integrated out and a series of coupled integro-differential equations are obtained on $f_\alpha(r_j)$. G. E. BROWN

539.153.4 : 537.533.74

465. Application of the integral equations for calculation of the effective cross section for collision of electrons with atoms. G. F. DRUKAREV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 2(8) 139–46 (1953) In Russian.

The formalism of the paper reported in the preceding abstract is applied to calculation of the cross-section for excitation of the 2S electron in hydrogen. The energy of the incoming electron is small enough so that only one level of the atom can be excited, and consequently only two different $f_\alpha(r_j)$ need be chosen, one representing something like the incident wave, and the other a scattered wave (although both contain ingoing and outgoing waves). The system of equations can be changed into a Volterra equation of second type with auxiliary algebraic equations. This form is convenient for studying the asymptotic behaviour of the functions. G. E. BROWN

539.153.4 : 537.533.74

466. Atomic factors of electron scattering. B. K. VAĬNSHTEĬN. *Zh. éksper. teor. Fiz.*, **25**, *No.* 2(8) 157–68 (1953) In Russian.

The form-factor for electron scattering, i.e., $f_{el}(s) = K \int \phi(r)\, e^{isr} d\tau$, where ϕ is the electrostatic potential of the atom plus screening electrons, is calculated for all elements and values of s. For light elements results are taken from other calculations; for medium and heavy elements, the Thomas–Fermi electron distribution is used to define ϕ. G. E. BROWN

539.154.2

467. Principal considerations in the periodic system of the elements. IX. Relationships between atomic nucleus and atomic shell. R. LEPSIUS AND K. S. ASUNMAA. *Naturwissenschaften*, **41**, *No.* 16, 366–8 (1954) In German.

For Pt VIII, see Abstr. 9530 (1954). The analysis of the plot P (number of protons) $v.$ $(N - P)$ ("neutron excess") for P values between 1 and 100 (only stable isotopes) shows that it is possible to insert a zig-zag line into the obtained area, which consists of vertical sections corresponding to the "main" groups of the periodic system, and inclined sections corresponding to the "subsidiary" groups (actinides, Lu–Hg, lanthanides, Y–Cd and Sc–Zn). While the ratio of $\Delta N/\Delta P$ is 1/1 in the main groups (periods), it is 2/1 in the subsidiary ones, the only deviation occurring in the Be–Mg period where 7 neutrons are added as against 8 protons. F. LACHMAN

539.155.2

468. Determination of the absolute concentration of deuterium in Thames river water. G. R. CLARKE, W. H. DENTON AND P. REYNOLDS. Letter in *Nature* [*London*] **174,** 469 (*Sept.* 4, 1954).

As determination from density measurements is complicated by the presence of O isotopes, a mass spectrometer method was followed. Standard water samples prepared from mixtures of natural water and heavy water were investigated and the concentration of deuterium determined. The results were corrected for tritium ions. The value found for Thames water lies in the higher part of the range found for American waters. A. J. TAYLOR

539.155.4

469. Atomic weights of the monoisotopic elements. H. E. DUCKWORTH. *Nature* [*London*] **174,** 595–6 (*Sept.* 25, 1954).

Accurate physical masses are known for 17 such elements. Values for the remaining 5 (Cs^{133}, Tb^{159}, Tm^{169}, Ta^{181}, Au^{197}) are obtained from a graph of mass defect for odd-A elements, supplemented by a curve tangent to the series of curves joining the even-A isotopes of even-Z elements. The odd-A nuclides of known physical mass are found to be displaced from this graph by a constant amount, and hence the masses of the remaining 5 can be estimated by interpolation. It is suggested that the official atomic weights of Tm, As, Y, Pr, Ta, Bi and Th should be revised to remove the discrepancies between these accurate physical and the chemical atomic weights, which are compared in a table for all 22 monoisotopic elements. A. J. TAYLOR

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

470. How important is surface contamination? M. EISENBUD, H. BLATZ AND E. V. BARRY. *Nucleonics*, **12,** *No.* 8, 12–15 (*Aug.*, 1954).

Surveys of surface contamination, airborne activity and the inhalation of activity by workers, in radium and uranium processing plants, showed that surface contamination is not a good criterion of personnel hazard. Air sampling and bioassay are more significant methods of monitoring. L. R. SHEPHERD

539.16.08 : 541.182.3

471. Autoradiography of atmospheric aerosols. G. ALIVERTI, A. DE MAIO, G. LOVERA AND R. PERILLI-FEDELI. *Nuovo Cimento*, **12,** *No.* 2, 270–8 (*Aug.*, 1954) In Italian.

In the radioactive decay scheme for the disintegration of Rn there is one product, RaA, which decays with the emission of two α-particles; in a nuclear emulsion such an atom will produce two tracks. The present paper is a theoretical and experimental examination of the frequency with which such double tracks would be expected and the results show that the method of electrical precipitation used is effective for RaA. J. M. HOUGH

539.162

472. Experimental verification of Migdal's theory. The case of polonium (Po^{210}). A. LAGASSE AND J. DOYEN. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 11, 670–2 (*Sept.* 13, 1954) In French.

A pair of counters were used to detect coincidences between K and L X-rays and the electrons emitted during the decay of Po^{210}. It is concluded from the intensity and energy distribution of these electrons, determined by absorption in Al, that they are ejected during the α-emission process, in agreement with the theory of Migdal. M. A. GRACE

539.163

473. Radiogenic osmium from rhenium-containing molybdenite. H. HINTENBERGER, W. HERR AND H. VOSHAGE. Letter in *Phys. Rev.*, **95,** *No.* 6, 1690–1 (*Sept.* 15, 1954).

Mass-spectrographic measurements were made on osmium recovered from rhenium-containing molybdenite, and showed it to be almost wholly radiogenic in origin (Os^{187}); the radioactivity of rhenium must therefore be ascribed to Re^{187}. A. O. STANESBY

539.163

474. Isotopes of curium, berkelium, and californium. E. K. HULET, S. G. THOMPSON AND A. GHIORSO. Letter in *Phys. Rev.*, **95,** *No.* 6, 1703–4 (*Sept.* 15, 1954).

See Abstr. 2949–50 (1951) for previous work. Cm^{245}: $E_\alpha = 5{\cdot}36 \pm 0{\cdot}05$ MeV, $\tau_{\frac{1}{2}} = 20\,000$ yr. Cf^{248}: $E_\alpha = 6{\cdot}26 \pm 0{\cdot}03$ MeV, $\tau_{\frac{1}{2}} = 250 \pm 20$ days; spontaneous fission $\frac{1}{2}$-life ~7000 yr. Bk^{246} (tentative): decays by electron-capture, $\tau_{\frac{1}{2}} = 1{\cdot}8$ days; γ-radiation of 820 ± 10 keV. Cf^{247}: decays by orbital electron-capture, $\tau_{\frac{1}{2}} = 2{\cdot}5$ hr. A. O. STANESBY

539.163

475. A 7-second iridium isomer. F. D. S. BUTEMENT AND A. J. POË. Letter in *Phil. Mag.*, **45,** 1090 (*Oct.*, 1954).

A 5·6 MeV γ-activity, of $\frac{1}{2}$-life 7 sec, previously reported in Ir [Abstr. 1604 (1954)] is due to contamination by N^{16} (7·3 sec) derived from traces of O_2 in the Ir metal used. The other activities (Ir k X-rays and a γ-ray of 125 keV) may then be attributed to Ir^{191m}. A. O. STANESBY

539.163 : 539.172.13

476. New isotope protactinium (237). W. W. T. CRANE AND G. M. IDDINGS. Letter in *Phys. Rev.*, **95,** *No.* 6, 1702–3 (*Sept.* 15, 1954).

Pa^{237} was produced by a (d, $2pn$) reaction on U^{238},

using 190 MeV deuterons; the ½-life is 10·5 ± 1 min, and the isotope decays by β^--emission. The cross-section was determined as a function of deuteron energy for $40 < E_d < 190$ MeV. A. O. STANESBY

539.163.1

477. Half-life of rhenium. W. HERR, H. HINTENBERGER AND H. VOSHAGE. Letter in *Phys. Rev.*, **95**, *No.* 6, 1691 (*Sept.* 15, 1954).

See also Abstr. 473 (1955). This was obtained from measurements of the Os and Re content of the molybdenite, giving the ½-life of Re^{187} as $91 \cdot 7t$ (t = age of mineral). For a (reasonable) age of 5×10^8 yr, the ½-life is 5×10^{10} yr, with limits between 5×10^9 and $2 \cdot 5 \times 10^{11}$ yr. [cf. Naldrett and Libby, Abstr. 1898, 2543 (1948)]. A. O. STANESBY

539.163.2

478. On the decay of ^{62}Zn, ^{62}Cu and ^{62}Co. R. H. NUSSBAUM, A. H. WAPSTRA, R. VAN LIESHOUT, G. J. NIJGH AND L. T. M. ORNSTEIN. Letter in *Physica*, **20**, *No.* 8, 571–2 (*Aug.*, 1954).

The β- and γ-spectra were examined, with the following conclusions: (*a*) the difference between the mass defects of Cu^{63} and Ni^{62} is 1·815 ± 0·054 mmu, against the mass-spectrometric measurements of 2·450 ± 0·090 mmu; this discrepancy affects a recent [Abstr. 686 (1954)] conclusion about the extra stability of 34 neutrons; (*b*) the 1·17 MeV γ-ray in Co^{62} represents the transition from the 1st excited state of Ni^{62}, and the 1·48 MeV level in Ni is probably to be assigned to Ni^{58}; (*c*) the ground and 1st excited states of Cu^{62} are both restricted to a spin 0 or 1, even parity. A. O. STANESBY

539.163.2

479. Decay scheme of Pb^{204m}. V. E. KROHN AND S. RABOY. Letter in *Phys. Rev.*, **95**, *No.* 5, 1354–5 (*Sept.* 1, 1954).

Coincidence measurements of the decay of 68-min Pb^{204m} have shown that 3 γ-rays are emitted in cascade, of energies 905 (to the $2 \cdot 6 \times 10^{-7}$ sec excited state) 374 and 890 keV; the order of the 2 latter was not determined experimentally. A. O. STANESBY

539.163.2

480. Radiations from Ir^{192m}. J. P. MIZE, M. E. BUNKER, AND J. W. STARNER. *Phys. Rev.*, **96**, *No.* 2, 444–7 (*Oct.* 15, 1954).

The photon and electron spectra of Ir^{192m} (1·42 min) have been thoroughly investigated. Study of the photon spectrum with scintillation spectrometers and an aluminum-lined proportional counter spectrometer revealed the presence of a quantum continuum, iridium L X-rays, and a 58 keV γ-ray. The quantum continuum was shown to be bremsstrahlung-engendered by conversion electrons from the isomeric transition. Previous to this study, the quantum continuum had been interpreted as possibly caused by "two-quantum" emission. A high-resolution, 180° permanent magnet spectrograph was employed for the examination of the conversion electron spectrum. The energy of the isomeric transition was found to be 58·0 ± 0·4 keV from the conversion electron studies. Lifetime-energy considerations and the observed L-subshell conversion ratios show that the 58·0 keV γ-ray is E3. The L-shell conversion coefficient was determined from scintillation spectrometer data to be $\geqslant 870$. A.

539.163.2

481. Long-lived radioactivity of Eu^{152} and Eu^{154}. R. E. SLATTERY, D. C. LU, AND M. L. WIEDENBECK. *Phys. Rev.*, **96**, *No.* 2, 465–8 (*Oct.* 15, 1954).

The long-lived activity of $Eu^{152,154}$ has been examined by means of a thin-lens coincidence spectrometer and a crystal-summing spectrometer. Decay schemes are given for Eu^{152} and Eu^{154}. A.

539.164

482. Natural radioactivity of platinum and neodymium. W. PORSCHEN AND W. RIEZLER. Note in *Z. Naturforsch.*, **9a**, *No.* 7–8, 701–3 (*July–Aug.*, 1954) In German.

Nuclear emulsion plates were impregnated with $K_2[Pt(CN)_4]$ and examined after development for α-particle tracks; a group of α-particle of range 11·6 ± 0·15 μ ($E_\alpha = 3 \cdot 3 \pm 0 \cdot 2$ MeV) was ascribed to Pt, and if the active isotope is Pt^{190}, the ½-life is $\sim 5 \times 10^{11}$ yr. Similarly for Nd, a group of range 6·27 ± 0·15 μ ($E_\alpha = 1 \cdot 8 \pm 0 \cdot 1$ MeV) was obtained; if the active isotope is Nd^{144}, the ½-life is $\sim 5 \times 10^{15}$ yr. Lower limits to the α-decay ½-lives of 16 other elements examined are also given. A. O. STANESBY

539.164.74 : 539.152.1

483. Elastic scattering of alpha particles by carbon. J. W. BITTNER AND R. D. MOFFAT. *Phys. Rev.*, **96**, *No.* 2, 374–7 (*Oct.* 15, 1954).

By using a propane gas target and 4·0 to 7·6 MeV α-particles from an electrostatic generator the elastic scattering differential cross-section of carbon has been measured with high resolution at five angles. A phase-shift analysis of the data indicates levels in O^{16} with the following energies, angular momenta, and parities: 10·36 MeV, $J = 4$, +; 11·25 MeV, $J = 0$, +; 11·51 MeV, $J = 2$, +; 11·62 MeV, $J = 3$, −; and 12·43 MeV, $J = 1$, −. Reduced widths of the 10·36, 11·25 and 11·62 MeV levels approach the Wigner limit for single-particle excitation. Comparison is made with levels predicted by the α-particle nuclear model. A.

539.165

484. Beta spectra of C^{14} and S^{35}. A. MOLJK AND S. C. CURRAN. *Phys. Rev.*, **96**, *No.* 2, 395–8 (*Oct.* 15, 1954).

The β-spectrum of C^{14} was measured with radioactive methane as the source in a proportional counter. To reduce end and side wall effects a pressure of 6 atm. (argon) was employed and a magnetic field of 3500 gauss was applied parallel to the counter axis. The spectrum of S^{35} was observed with the same equipment. The theoretical allowed spectrum for this source was modified according to calculations made to take into account the instrumental limitations. The modified theoretical form agreed excellently with the observations down to energies below 5 keV. With the sulphur spectrum as an experimental standard for an allowed shape very accurate empirical correction factors could be obtained, and these were applied to the data for C^{14}. The adjusted data for C^{14} were found to follow the theoretical shape for an allowed transition to within 1% accuracy at energies above about 3 keV. A.

539.165

485. On the orbital electron capture in ^{195}Au. A. Bisi and L. Zappa. *Nuovo Cimento*, **12**, *No.* 4, 539–47 (*Oct.*, 1954).

The integrating features of the proportional counter spectrometer were used to investigate the electron capture decay in Au^{195}. The transition energies to the excited levels of ^{195}Pt were found to be $(E_0)_{d3/2-f5/2} = 143 \pm 17$ keV, $(E_0)_{d3/2-p3/2} = 172 \pm 17$ keV. The two transitions are classified as once-forbidden ($\Delta I = 0, 1$, yes). A.

539.165.2

486. Analysis of the phenomenon of formation of monochromatic positrons. L. A. Sliv. *Zh. éksper. teor. Fiz.*, **25**, *No.* 1(7) 7–18 (1953) In Russian.

Monochromatic positrons can be formed by a nuclear transition with pair formation (the cases of formation from electric dipole and quadrupole and magnetic quadrupole radiation from the nucleus and of pair-production accompanying a 0–0 transition are calculated) in which case the electron must be formed in an unfilled state of the screening electrons if monochromatic positrons are to be formed. These positrons can be labelled as *K*, *L*, etc., positrons corresponding to electron formation in the *K*, *L*, etc. levels. For this process to take place, one of the electron states must be empty. This might take place (*a*) in a nuclear transition by γ-cascade, where one of the γ-rays ionizes the nucleus and another forms the pair, or (*b*) after *K*-capture, if the transition of the excited nucleus releases enough energy to produce pairs. Conversion coefficients for formation of *K*, *L*, etc., positrons are given. G. E. BROWN

539.165.2

487. Influence of nuclear structure on the probability of *K*-capture. L. P. Rapoport. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 282–8 (1953) In Russian.

The changes in the probabilities of first- and second-forbidden transitions are calculated taking into account the finite extent of the nucleus, which is visualized as having a constant charge density with radius *R*. The ratio $w_K/w_{\beta+}$, where w_K is the probability of *K*-capture and $w_{\beta+}$ is the probability of positron emission, is decreased by the finite nuclear extension. G. E. BROWN

539.165.2

488. Electron wave-functions inside the nucleus. III. Application to the β-spectrum of RaE. R. Nataf. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 3, 341–4 (*July* 26, 1954) In French.

For previous parts, see Abstr. 6804, 7696 (1954). The β-spectrum, even when corrected for the modification of the wave-function of the nuclear surface, is not entirely satisfactory either with the assumption of a $0 - \rightarrow 0+$ or a $1 - \rightarrow 0+$ transition. W. J. SWIATECKI

539.165.2

489. Mesonic corrections to the beta-decay coupling constants. R. J. Finkelstein and S. A. Moszkowski. Letter in *Phys. Rev.*, **95**, *No.* 6, 1695–7 (*Sept.* 15, 1954).

The mean of the ratio of Gamow–Teller to Fermi coupling constants g_{GT}^2/g_F^2 deduced from n^1–H^1 H^3–He^3, O^{15}–N^{15}, F^{17}–O^{17} decays is 1·6. The deviation from 1·0 can be accounted for as a 1st-order mesonic correction involving the emission and re-absorption of 1 π^0-meson. W. J. SWIATECKI

539.165.2 : 530.145

490. Nuclear forces and β decay matrix elements. R. F. Herbst. *Phys. Rev.*, **96**, *No.* 2, 372–3 (*Oct.* 15, 1954).

The matrix elements of β-decay are reduced to nonrelativistic form under the assumption that the nuclear Hamiltonian contains interactions involving odd operators. Particular attention is given to an interaction which gives rise to a spin orbit effect. A.

539.165.8 : 537.533.74

491. Backscattering from targets of low atomic number bombarded with 1–2 MeV electrons. J. Saldick and A. O. Allen. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1777 (*Oct.*, 1954).

Further measurements on the fraction of "high-energy secondaries" back-scattered from 1 and 2 MeV electrons incident perpendicularly on thick targets show that the fraction varies nonlinearly with *Z* for low *Z*, and that previously reported [Abstr. 4898 (1954)] *G* values for 0·8 N $FeSo_4$ solutions should be increased by 1·73% at 2 MeV and 1·07% at 1 MeV. A. O. STANESBY

539.166

492. 3·20 MeV γ-radiation of ThD determined by the photographic emulsion technique. H. Niewodniczański and M. Wielowiejska. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 7, 293–6 (1953).

Photographic emulsions were used to detect photoneutrons ejected from a beryllium target when irradiated by a MsTh source. The observations indicated 2·62 and 3·20 MeV γ-rays, with intensities in the ratio 10 : 1. J. J. WILKINS

539.166

493. Absolute intensities of the gamma rays and X-rays of radium D. P. E. Damon and R. R. Edwards. Letter in *Phys. Rev.*, **95**, *No.* 6, 1698–9 (*Sept.* 15, 1954).

Using scintillation spectrometry and 2π α-counting methods, the intensities found were: 46·5 keV line, $3·8 \pm 0·6$; (31 ± 1) keV line, $0·6 \pm 0·2$; *L* X-rays, 19 ± 3 (% of total disintegrations). Upper limits are given for the intensities of other, previously reported rays. J. J. WILKINS

539.166 : 545.824

Gamma absorptiometry: A new tool for analytical chemistry. *See Abstr.* 612

539.166.08

494. Photographic dosimetry of X- and gamma rays. M. Ehrlich. *Handb. Nat. Bur. Stand., No.* 57, 28 *pp.* (1954).

A survey of basic physical data for dosimetry with commercial films. The paper includes sensitivity and dosage range curves, development factors and temperature effects on latent image, directional effects in emulsions for a range of radiation qualities and build-up factors for the higher energy radiations. Reproducibility to 1½%, using films of any one batch, can be achieved by careful operation. F. T. FARMER

539.166.08

495. Gamma-ray dosimetry with cellophane-dye systems. E. J. HENLEY. *Nucleonics*, **12**, *No.* 9, 62–3 (*Sept.*, 1954).

Dosage is measured by the change in transmission, at 6550 Å, in cellophane films containing dimethoxy–diphenyl-disazo-bis-8-amino-1-naphthol-5, 7-disulphonic acid dye. The change in transmission varies linearly with dosage up to 3×10^6 r. L. R. SHEPHERD

539.166.2 : 539.18

Radiation of γ-rays on collision of fast π-mesons with nucleons. *See Abstr.* 550

539.166.74

496. The Compton scattering of a circularly polarized quantum by an electron with a given spin direction. G. M. GANDEL'MAN. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4(10) 429–34 (1953) In Russian.

The differential cross-sections in the range 0–180° for left and right circularly polarized quanta are worked out by the Feynman method. [cf. Abstr. 2089 (1949), 900 (1950) and 5696 (1953)]. The results are tabulated in a form convenient for comparison with experiment, for photon energies 1 and 4 mc^2. The cross-sections are also plotted as functions of the angle of the recoil electron (ψ) for the scattering by the electrons in magnetized Fe (assumed electron spin alignment given by 14·1 positive to 11·9 negative spins per Fe atom). They increase with decreasing ψ, the ratio of σ (spin || to photon momentum) to σ (antiparallel) at $\psi = 180°$ being ~10 for energy 1 mc^2 and ~100 for energy 4 mc^2. W. J. SWIATECKI

539.166.83 : 537.534.8

Auger ejection of electrons from tungsten by noble gas ions. *See Abstr.* 345

539.166.83 : 537.534.8

Theory of Auger ejection of electrons from metals by ions. *See Abstr.* 346

539.166.835

497. Emission of electron-positron pairs from light nuclei. III. γ-transitions in the reaction $^{15}N(p, \gamma)^{16}O$. G. GOLDRING. *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 930–4 (*Oct.*, 1954).

For Pt II, see Abstr. 7712 (1954). An apparatus is described for the investigation of internal pairs produced in a N^{15} gas target by proton bombardment. A search was made for a cascade transition from the 13·05 MeV level in O^{16} through the 6·06 MeV level to the ground state, but no indication for such a reaction could be found. A.

539.166.835 : 537.533.8

498. Bremsstrahlung and the creation of pairs in the field of the electron. G. M. GARIBYAN. *Zh. éksper. teor. Fiz.*, **24**, *No.* 6, 617–21 (1953) In Russian.

Three processes: (*a*) and (*b*) radiation accompanying electron-positron and electron-electron collisions; and (*c*) creation of pairs in the electron field by a γ-ray, are considered for the extreme cases of very small and very large energies. The formulae are taken from previous work [*Izvestiya Akademii Nauk Armyanskoi S.S.R.*, **5**, 3 (1952)] where they prove to be too complex to discuss in the general case. G. E. BROWN

539.167.3

499. Production of iodine-132. L. G. STANG, JR, W. D. TUCKER, H. O. BANKS, JR, R. F. DOERING AND T. H. MILLS. *Nucleonics*, **12**, *No.* 8, 22–4 (*Aug.*, 1954).

The production and separation of 77 hr Te^{132}, from fission products in pile-irradiated U_3O_8, is described. The Te^{132} is shipped as dioxide and the I^{132} is milked from this by taking it into solution in caustic soda and adding acetic acid to precipitate the TeO_2. L. R. SHEPHERD

539.169

500. Problems encountered in routine use of 10-kilocurie, gamma-radiation source. J. V. NEHEMIAS, L. E. BROWNELL, W. W. MEINKE AND D. E. HARMER. *Amer. J. Phys.*, **22**, *No.* 8, 511–16 (*Nov.*, 1954).

During a year of routine use operational problems have been encountered in control of radiation levels in nearby areas, control of pH and clarity of the water in the source storage well, breakdown of organic plastics under prolonged irradiation, and a discrepancy between nominal and apparent source strength. A short discussion of these problems and the resulting changes in operational procedures is presented. A.

NUCLEAR REACTIONS 539.17

539.172

Nuclear reactions due to cosmic rays. *See also under* "Cosmic rays." Decimal classification 537.591.8

539.172

501. Absorption of positive pions by deuterium at 76 and 94 MeV. H. L. STADLER. *Phys. Rev.*, **96**, *No.* 2, 496–502 (*Oct.* 15, 1954).

The absorption of positive pions by liquid deuterium has been studied with scintillation counters, using a collimated pion beam from the Chicago synchrocyclotron. The differential cross-sections for the production of protons at angles of 35°, 45°, 60° and 90° are 1·189 ± 0·076, 0·926 ± 0·058, 0·643 ± 0·061 and 0·442 ± 0·052 millibarns per steradian at 94 MeV and 1·010 ± 0·102, 0·718 ± 0·081, 0·431 ± 0·073 and 0·300 ± 0·058 millibarns per steradian at 76 MeV in the centre-of-mass system. The angular distribution can be represented by $a + \cos^2\theta$ with the following values of a: 0·268 ± 0·089 at 76 MeV and 0·388 ± 0·082 at 94 MeV. The total cross-sections are 7·38 ± 1·21 millibarns at 76 MeV and 9·70 ± 1·03 millibarns at 94 MeV. A.

539.172.11

502. Angular distribution of protons emitted in the reaction $_7N^{14}(\alpha, p)_8O^{17}$. G. S. MANI AND R. PANDHI. *Proc. Indian Acad. Sci. A*, **40**, *No.* 2, 61–6 (*Aug.*, 1954).

Resonance levels at 2·0, 3·6 and 4·1 MeV in the compound nucleus F^{18} have been identified from 350 proton tracks in a cloud-chamber using a source of Po α-particles. The angular distribution of these protons indicates that the levels at 3·6 and 4·1 MeV are mainly excited by *p*-waves while that at 2·0 MeV is a mixture of levels of opposite parity and is excited by a mixture of *s* and *p* waves. M. A. GRACE

539.172.11

503. Inelastic scattering of alpha particles by lithium. C. W. Li and R. Sherr. *Phys. Rev.*, **96**, *No.* 2, 389–93 (*Oct.* 15, 1954).

The inelastic scattering of α particles by Li^7 leading to the formation of the 478 keV state of Li^7 has been studied by observation of the γ-ray emitted from that state. Singly charged helium ions accelerated by an electrostatic generator were used to determine the yield of the reaction up to an energy of 2·8 MeV. The excitation curve shows a resonance at $1{\cdot}889 \pm 0{\cdot}010$ MeV, with a width of 200 keV and a peak cross-section of $0{\cdot}11 \pm 0{\cdot}02$ barns, and another broad resonance at $2{\cdot}50 \pm 0{\cdot}03$ MeV with a peak cross-section of $0{\cdot}08 \pm 0{\cdot}015$ barns. These resonances correspond to levels of B^{11} at 9·86 MeV and 10·23 MeV. The thick target yield at $E_\alpha = 2{\cdot}3$ MeV is $1{\cdot}5 \times 10^{-6}\gamma/\alpha$. The Doppler shift of the emitted γ-ray furnishes an upper limit of the lifetime for the 478 keV excited state of Li^7. A.

539.172.13

504. The yield curve of the $^7Li(p, \gamma)^8Be$ reaction. P. C. Price. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 9, 849–51 (*Sept.*, 1954).

This was examined for incident proton energies between 0·5 and 2·5 MeV, and shows a resonance at ~1 MeV and possibly another at 2 MeV.

A. O. Stanesby

539.172.13

505. On the interaction of 340 MeV protons with the light and heavy nuclei of photographic emulsion. P. Cüer and J. Combe. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 4, 351–3 (*July* 26, 1954) In French.

For the heavy nuclei the experimental results are in good agreement with a cascade process, analysed by the Monte Carlo method. The effect of the motion of the nuclei is appreciable. For light nuclei it is not sufficient to assume independent motion. The hypothesis of some instantaneous sub-structure is essential. P. T. Matthews

539.172.13

506. Variation of the yield of Coulomb excitation for the first two rotational levels of tantalum by protons of energy between 1·2 and 4·5 MeV. R. Barloutaud and T. Grjebine. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 6, 491–3 (*Aug.* 9. 1954) In French.

The thick target yields of 137, 166 and 303 keV γ-radiation were measured at an angle of 55° to the proton beam with a scintillation counter. The dependence of these yields on proton energy is in good accord with the theory. M. A. Grace

539.172.13

507. Polarization of fast neutrons from nuclear reactions. H. B. Willard, J. K. Bair and J. D. Kington. Letter in *Phys. Rev.*, **95**, *No.* 5, 1359–60 (*Sept.* 1, 1954).

The polarization of the neutrons from the reaction $Li^7(p, n)Be^7$ at the 2·22 MeV resonance, was measured by elastic scattering from the O^{16} in a water scatterer. The polarization of neutrons emitted at 42° was found to be $0{\cdot}50 \pm 0{\cdot}04$. J. Hughes

539.172.13

508. Asymmetry in neutron production by bombarding targets with 285-MeV polarized protons. H. Bradner and R. Donaldson. Letter in *Phys. Rev.*, **95**, *No.* 6, 1701–2 (*Sept.* 15, 1954).

The initial polarization was $65 \pm 3\%$, the c.m. angles of the "quasi-elastically" scattered neutrons (also protons) 30°–140° and the targets C, Be, Li. The polarizations are of the order 20%, positive for $\theta \lesssim 90°$, negative for $\theta \gtrsim 90°$. W. J. Swiatecki

539.172.13

509. Disintegration of bismuth by 2·2-BeV-protons. N. Sugarman, R. B. Duffield, G. Friedlander and J. M. Miller. Letter in *Phys. Rev.*, **95**, *No.* 6, 1704–5 (*Sept.* 15, 1954).

A brief account is given of the production of some isotopes when Bi is bombarded with protons. A table showing a monotonic decrease in the cross-section for production with decreasing Z suggests that the reactions proceed mainly by spallation rather than by fission. M. A. Grace

539.172.13

510. Scattering of polarized neutrons from heavy nuclei. R. K. Adair, S. E. Darden and R. E. Fields. *Phys. Rev.*, **96**, *No.* 2, 503–7 (*Oct.* 15, 1954).

The polarization of 400 keV $Li(p, n)$ neutrons emitted at a laboratory angle of 50° with respect to the incident proton beam was measured to be $53 \pm 6\%$ by determining the left-right asymmetry in the intensity of neutrons scattered at 90° from oxygen. Oxygen scattering phase shifts necessary for this calculation were derived from the results of previous experiments. Left-right scattering asymmetries were measured for 11 elements, ranging in atomic weight from copper to bismuth. From these asymmetries the magnitudes of the polarizations caused by the heavy nuclei were determined. The variation of the polarization with atomic number appeared similar to that expected from the square well-with-absorption nuclear model of Feshbach, Porter and Weisskopf, modified by the addition of a spin-orbit term equal to $-1{\cdot}5$ MeV ($\mathbf{l} \cdot \mathbf{s}$). A.

539.172.13

511. Angular distribution and yield of protons from the $^{10}B(d, p)^{11}B$ reaction. II. C. H. Paris, F. P. G. Valckx and P. M. Endt. *Physica*, **20**, *No.* 9, 573–84 (*Sept.*, 1954).

In a previous paper [Abstr. 8453 (1952)] angular distribution measurements have been described of four proton groups from the $^{10}B(d, p)^{11}B$ reaction at a deuteron energy of $E_d = 0{\cdot}31$ MeV. In the present investigation measurements were added at $E_d = 0{\cdot}20$, 0·45 and 0·60 MeV. The differential cross-section at $\delta = 120°$ has also been determined as a function of deuteron energy ($E_d = 0{\cdot}175 - 0{\cdot}700$ MeV) by means of a proton scintillation spectrometer. The relative intensities of the four proton groups show irregularities at $E_d = 0{\cdot}21$ MeV corresponding to a new C^{12} resonance level at an excitation energy of 26·93 MeV. Angular distributions have been analysed into a stripping contribution and a contribution from compound nucleus formation. It is shown that the stripping contribution is large for at least two of the four proton groups down to the lowest deuteron energies. The values found by Butler analysis for the angular momentum transfer l_n are in agreement with known spins and parities. A.

539.172.13

512. Angular distributions of four neutron groups from the $^{10}B(d, n)^{11}C$ reaction. C. H. PARIS AND P. M. ENDT. *Physica*, **20**, *No.* 9, 585–91 (*Sept.*, 1954).

Measurements are described of the angular distributions of the four most energetic neutron groups from the $B^{10}(d, n)C^{11}$ reaction at a deuteron energy of 0·6 MeV. Neutrons were detected by their recoil protons in nuclear emulsions. The angular distributions have been analysed in terms of a stripping contribution and an assumedly isotropic contribution from compound nucleus formation. From Butler analysis $l_p = 1$ is found for the stripping contribution of the neutron group leading to the C^{11} ground state, and $l_p = 0$ for the group leading to the second excited state. This is in agreement with previous results obtained from the mirror reaction $B^{10}(d, p)B^{11}$ and with predictions from the nuclear shell model. Stripping contributions of the other two neutron groups are very small. A.

539.172.13

513. The reaction $^9Be(d, ^3He)^8Li$. M. M. WINN. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 946–8 (*Oct.*, 1954).

Evidence for this reaction was found in the bombardment of Be by 20 MeV deuterons, the Li^8 being detected by means of its decay α-particles. A rough yield curve is consistent with the calc. d threshold energy of 13·9 MeV. A. O. STANESBY

539.172.13

514. Gamma radiation from deuterons on several light nuclei. L. C. THOMPSON. *Phys. Rev.*, **96**, *No.* 2, 369–72 (*Oct.* 15, 1954).

A single-crystal NaI scintillation spectrometer has been used to measure the energy of γ rays from $B^{10} + d$, $B^{11} + d$, $N^{14} + d$, $C^{12} + d$, $F^{19} + d$, and $Si^{28} + d$. Several γ rays were found and their energy and relative intensity are given. It is also deduced what transitions these γ rays represent. A.

539.172.13

515. Production of tritons in high-energy deuteron-deuteron collisions. C. S. GODFREY. *Phys. Rev.*, **96**, *No.* 2, 493–5 (*Oct.* 15, 1954).

The differential cross-section for the process $d + d \rightarrow H^3 + p$ has been measured at six angles extending from 20° to 85° in the centre-of-mass system. Deuterons of 190 MeV from the Berkeley 184-inch synchrocyclotron were used. A coincidence counting system, consisting of scintillation counters for both particles, was employed. Time of flight and range of the particles were made use of, both in identifying the process and in discriminating against background. The resulting cross-section is highly peaked in the forward direction. The behaviour is explained qualitatively by a theoretical calculation based on an extension of the stripping mechanism first proposed by Serber. The total cross-section for the reaction is estimated to be 4·1 millibarns. A.

539.172.13

516. Short-lived alpha emitters produced by ^3He and heavy ion bombardments. M. M. WINN. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 949–50 (*Oct.*, 1954).

Preliminary report. The internal beam of heavy ions ($^3He^{2+}$, $^{14}N^{6+}$, etc.), of the Birmingham cyclotron has been used to bombard various targets, and the α-decay ($\frac{1}{2}$-lives 0·1–60 sec) of the product nuclei followed inside the cyclotron using a special internal probe. A. O. STANESBY

539.172.3

517. Photo-disintegration of the deuteron by high energy γ-rays. A. M. KOROLEV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 2(8) 188–90 (1953) In Russian.

The electromagnetic field is coupled not only to the nucleons as in the phenomenological theory, but also with mesons in intermediate states. (Pseudoscalar mesons are employed with pseudoscalar and pseudovector coupling to the nucleons.) Qualitative agreement with the slow decrease of the experimental cross-section up to 140 MeV and the rise beyond that point is obtained with the pseudovector coupling. G. E. BROWN

539.172.3

518. Angular distribution of photo-neutrons from beryllium. H. NIEWODNICZAŃSKI AND M. WIELOWIEJSKA. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 1, 25–9 (1954).

This has been measured for 2·62 and 3·20 MeV (ThD) γ-rays, using nuclear emulsion detectors placed at 0° and 90°. Assuming a distribution of the general form $a + b \sin^2\theta$, the results are $a/b = 1{\cdot}56 \pm 0{\cdot}11$ at 2·62 MeV, and $a/b = 1{\cdot}26 \pm 0{\cdot}16$ at 3·20 MeV. J. J. WILKINS

539.172.3

519. Study of the reaction $Ag^{109}(\gamma, \alpha)Rh^{105}$. H. DE LABOULAYE AND J. BEYDON. Letter in *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 5, 411–14 (*Aug.* 2, 1954) In French.

The cross-section has been measured up to 22 MeV γ-ray energy, the Rh^{105} being extracted chemically. The cross-section is $\sim 10^3$ greater than expected from statistical theory. J. J. WILKINS

539.172.4

520. Study of the nuclear reaction $Be^9(n, 2n)Be^8$. V. I. MAMASAKHLISOV. *Zh. éksper teor. Fiz.*, **25**, *No.* 1(7) 36–9 (1953) In Russian.

The incident neutron is taken as free and the final neutron in Be^9 is assumed to move in a P state in a square well of depth 12 MeV and radius 5×10^{-13} cm. The interaction between these two neutrons is assumed to be of a δ-function character. The two off-coming neutrons are taken to be free. The cross-section obtained is $\sigma \simeq 0{\cdot}08 \times 10^{-24}(\gamma - 1)^2/\gamma^{1/2}$ cm^2, where $\gamma = E/\varepsilon$, ε is the binding energy of the final neutron in Be^9 and E is the energy of the incident neutron. This is in reasonable agreement with experiment. G. E. BROWN

539.172.4

521. The absolute value of the resonance integral of gold. D. POPOVIĆ. *Z. Naturforsch.*, **9a**, *No.* 7–8, 600–2 (*July–Aug.*, 1954) In German.

By measuring the influence of a Cd filter on (*a*) the activation of gold foils by a beam of pile neutrons, and (*b*) the counting rate of a boron counter, the resonance integral was deduced to be 1326 ± 15 barn. W. J. SWIATECKI

539.172.4

522. Inelastic neutron scattering in iron. D. L. Lafferty, L. A. Rayburn and T. M. Hahn. *Phys. Rev.*, **96**, *No.* 2, 381 (*Oct.* 15, 1954).

The γ-ray spectrum from the inelastic scattering of *D–D* neutrons in iron has been obtained using an unshielded single-crystal NaI spectrometer. A ring-type geometry permitted subtraction of the background rate from the total rate: this yields a complex spectrum attributed to the inelastic scattering in iron. Energies have been assigned to the peaks of the complex spectrum indicating γ-rays of 2·66, 2·10, 1·76, 1·59, 1·42, 1·24, 0·989, 0·851, 0·634 and 0·462 MeV. A.

539.172.4

523. Gamma radiation from interaction of 3·2-MeV neutrons with various materials. V. E. Scherrer, B. A. Allison and W. R. Faust. *Phys. Rev.*, **96**, *No.* 2, 386–8 (*Oct.* 15, 1954).

Gamma radiation arising from 3·2 MeV neutron bombardment of 30 elements has been observed and calculations made of the γ-ray production cross-section for 15 of these elements. A.

539.172.4

524. Model for nuclear reactions with neutrons. H. Feshbach, C. E. Porter and V. F. Weisskopf. *Phys. Rev.*, **96**, *No.* 2, 448–64 (*Oct.* 15, 1954).

A simple model is proposed for the description of the scattering and the compound nucleus formation by nucleons impinging upon complex nuclei. It is shown that, by making appropriate averages over resonances, an average problem can be defined which is referred to as the "gross-structure" problem. Solution of this problem permits the calculation of the average total cross-section, the cross-section for the formation of the compound nucleus, and the part of the elastic-scattering cross-section which does not involve formation of the compound nucleus. Unambiguous definitions are given for the latter cross-sections. The model describing these properties consists in replacing the nucleus by a one-body potential which acts upon the incident nucleon. This potential $V = V_0 + iV_1$ is complex; the real part represents the average potential in the nucleus; the imaginary part causes an absorption which describes the formation of the compound nucleus. As a first approximation a potential is used whose real part V_0 is a rectangular potential well and whose imaginary part is a constant fraction of the real part $V_1 = \zeta V_0$. This model is used to reproduce the total cross-sections for neutrons, the angular dependence of the elastic scattering, and the cross-section for the formation of the compound nucleus. It is shown that the average properties of neutron resonances, in particular the ratio of the neutron width to the level spacing, are connected with the gross-structure problem and can be predicted by this model. The observed neutron total cross-sections can be very well reproduced in the energy region between zero and 3 MeV with a well depth of 42 MeV, a factor ζ of 0·03, and a nuclear radius of $R = 1{\cdot}45 \times 10^{-13} A^{\frac{1}{3}}$ cm. The angular dependence of the scattering cross-section at 1 MeV is fairly well reproduced by the same model. The theoretical and experimental values for the ratios of neutron width to level distance at low energies and the reaction cross-sections at 1 MeV do not agree too well but they show a qualitative similarity. A.

539.172.4

525. An indirect measurement of the *n–n* interaction. R. H. Phillips and K. M. Crowe. *Phys. Rev.*, **96**, *No.* 2, 484–92 (*Oct.* 15, 1954).

The γ-ray spectrum from the process $\pi^- + d \rightarrow 2n + \gamma$ has been remeasured using a high-resolution 110-channel pair spectrometer. The negative pions produced in an internal target by 335 MeV protons of the Berkeley 184-inch cyclotron, are captured at rest in a high-pressure deuterium vessel. Comparison of the spectrum with the γ-ray spectrum from the process $\pi^- + p \rightarrow n + \gamma$ measured with the same apparatus shows the effect of the *n–n* interaction as a broadening of approximately three times the resolving width. In spite of the low counting rates and resulting statistical inaccuracy it is possible to establish limits for the scattering length "*a*" for *S*-state neutron-neutron scattering. The experimental data are analysed by evaluating a weighted first moment of the spectrum. Comparison of the weighted first moments of the theoretical spectra with that of the data leads to a value of $a = -15{\cdot}9 \times 10^{-13}$ cm with limits, based on the probable error, of $a = -8{\cdot}5 \times 10^{-13}$ cm and $a = -\infty$ cm. The value $a = -15{\cdot}9 \times 10^{-13}$ cm corresponds to an unbound state (~160 keV positive) for the hypothetical dineutron. The bound dineutron of more than 50 keV is less than 0·1% probable. This result is consistent with the *n–p* and *p–p* scattering data and is in agreement with the theory of charge independence of nuclear forces. A.

539.172.4 : 539.152.1

526. Studies of intermediate and heavy nuclei with neutrons. H. H. Barschall. *Amer. J. Phys.*, **22**, *No.* 8, 517–23 (*Nov.*, 1954).

Experimental results on the interaction of neutrons with intermediate and heavy nuclei are summarized. Until recently the interaction of nucleons with nuclei has usually been described in terms of the compound nucleus theory. The data presented can, however, not be accounted for by the compound nucleus theory. It appears to be necessary to assume instead that a neutron can traverse a nucleus rather easily with only a small chance of being absorbed into a compound system. Feshbach, Porter and Weisskopf have proposed an optical potential consisting of a complex square well to account for the experimental data. While this model gives better agreement with the experiments than the compound nucleus theory, it leads to some inconsistencies. In order to be consistent with the results of measurements on neutrons and with the shell model the potential needs to be modified to be deeper than that used by Feshbach *et al.*, and it should contain a spin-orbit coupling term. A.

539.172.4

527. Spontaneous fission properties of elements 97, 98, 99 and 100. P. R. Fields, M. H. Studier, L. B. Magnussen and J. R. Huizenga. Letter in *Nature* [*London*] **174**, 265–6 (*Aug.* 7, 1954).

A table is given of some properties of elements 97–100. The spontaneous fission half-lives of some

even–even nuclides deviate from the predicted values. [See Abstr. 5975 (1954)]. M. A. GRACE

539.172.4

528. Development of the second French reactor. L. KOWARSKI. *Nucleonics*, **12**, *No.* 8, 8–11 (*Aug.*, 1954).

A short historical account of the design and operational experience of the Saclay reactor. The reactor is heavy-water-moderated with 3 tons of natural uranium fuel cooled by pressurized nitrogen. It operates up to 1500 kW and the maximum metal temperature so far reached is 200°C. L. R. SHEPHERD

539.172.4

529. In a heavy water reactor: How do gamma rays affect reactivity? A. LUNDBY. *Nucleonics*, **12**, *No.* 8, 25–7 (*Aug.*, 1954).

Perturbation calculations on the effect on reactivity of photoneutrons produced by γ-ray sources in a D_2O moderated reactor are given. Both external sources and inherent ones (caused by neutron capture) are considered. The inherent sources include prompt gammas and radiations from the activities resulting from neutron capture. L. R. SHEPHERD

539.172.4

530. Fluidized- and liquid-fuel reactors with uranium oxides. J. J. WENT AND H. DE BRUYN. *Nucleonics*, **12**, *No.* 9, 16–19 (*Sept.*, 1954).

The feasibility of two types of reactor using natural or slightly enriched UO_2 powder as fuel, is examined. In the first type, the fuel is in the form of a suspension in the D_2O moderator, while the second type utilizes the fuel in the form of fine solid particles fluidized in a gas stream which flows downwards in channels through the moderator. The advantage of using such systems lies mainly in the possible high burnup, good heat transfer and the possibility of continuous fission product removal. Flow schemes are given for both systems and investigations of the stability of the suspensions and fluidized fuels are described. L. R. SHEPHERD

539.172.4

531. Failure and disassembly of Los Alamos fast reactor. E. T. JURNEY. *Nucleonics*, **12**, *No.* 9, 28–30 (*Sept.*, 1954).

The reactor, Clementine, employed Pu fuel, Hg coolant, and operated at 25 kW. Failure was due to rupture of one of the steel-cased fuel rods, which allowed Pu to escape into the coolant, and corrosion of the U reflector and safety block, which prevented the latter from functioning properly. The steps taken to minimize radiation- and Pu contamination-hazards during dismantling are described. L. R. SHEPHERD

539.172.4

532. Design for a high-performance research reactor. J. P. GILL. *Nucleonics*, **12**, *No.* 9, 36–8 (*Sept.*, 1954).

The reactor, to be constructed at ORNL, is light-water-cooled and moderated, with enriched U fuel ($3{\cdot}3$ kg U^{235}), in the form of curved Al-clad Al–U alloy plates, and using a Be reflector. At an operating power of 10 MW, the thermal neutron flux in the reflector reaches $1{\cdot}6\times10^{14}$ n/cm^2/sec. The construction and experimental facilities are described. L. R. SHEPHERD

539.172.4

533. Evaluating reactor hazards from airborne fission products. R. B. MESLER AND L. C. WIDDOES. *Nucleonics*, **12**, *No.* 9, 39–41 (*Sept.*, 1954).

Contamination concentration, down-wind from the source, is calculated on the basis of Sutton's diffusion formula, assuming that all the fission products have reached maximum concentration at the given reactor power level and are all released at a point. Calculations are carried out for moderate lapse and large inversion conditions. The concentrations determined in this manner are then used to calculate integrated external doses and inhalation doses received by observers engulfed by the radioactive cloud. Dose-rates resulting from fall-out are also calculated. L. R. SHEPHERD

539.172.4

534. Nonuniform fuel distributions in nuclear reactors. G. GOERTZEL AND W. A. LOEB. *Nucleonics*, **12**, *No.* 9, 42–5 (*Sept.*, 1954).

The advantages of non-uniform distributions of fuel and coolant in a reactor core are outlined. The distribution of fuel and coolant in a fast reactor, with flat uniform plate core and a reflector, to give a uniform rate of heat production throughout the core, is analysed on one-group diffusion theory. The problem of obtaining uniform power per unit mass of fuel and per unit volume of core in a thermal reactor is also analysed. L. R. SHEPHERD

539.172.4

535. How to shield reactor beams. W. P. STINSON. *Nucleonics*, **12**, *No.* 9, 50–4 (*Sept.*, 1954).

The attenuation of a narrow beam of pile neutrons and γ-radiation inside blocks of boron-loaded paraffin wax and in aqueous boric acid solution in a tank was studied with a BF_3 counter and NaI scintillation γ-detector. The method of utilizing the results to design beam traps is described. L. R. SHEPHERD

539.172.4

536. Kinetics of piles with reflectors. V. H. RUMSEY. *J. appl. Phys.*, **25**, *No.* 11, 1395–9 (*Nov.*, 1954).

An integral equation for the time-dependent reaction is derived on the basis of the two-group model of neutron multiplication. When the effective multiplication constant is given, the solution reduces to a determination of the mean time T between consecutive generations, which is largely controlled by the circulation of neutrons in the reflector. If the steady distribution is known, T can be calculated from a simple formula. To illustrate the orders of magnitude which are involved, T was calculated for a small pile surrounded by an infinite reflector. A value of $T = 450$ μsec was obtained assuming a mean lifetime in the core of 50 μsec and a mean lifetime in the reflector of 14 000 μsec. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

537. Heavy neutral particles. M. CONVERSI. *Nuovo Cimento Suppl.*, **12**, *No.* 1, 35–55 (1954) In Italian.

An account and discussion of work done on heavy neutral particles up to the end of May 1954. P. ROTHWELL

539.18

538. Heavy charged particles. N. DALLAPORTA. *Nuovo Cimento Suppl.*, **12**, *No.* 1, 56–66 (1954) In Italian.

An account and discussion of work done on heavy charged particles up to the end of 1953. P. ROTHWELL

539.18

539. Experiments on μ-mesons at Manchester and Ceylon. A. W. WOLFENDALE. *Nuovo Cimento Suppl.*, **12**, *No.* 1, 107–10 (1954).

Gives a short review of measurements on the μ-meson spectrum up to 100 GeV/c, on ionization loss of μ-mesons in the momentum range 1·5 to 100 GeV/c, on the large-angle scattering of μ-mesons using multi-plate cloud chambers and nuclear emulsions and of a search for associated penetrating particles using a cloud chamber in a magnetic field operated in Ceylon. H. ELLIOT

539.18

540. An example of V_1^0-decay recorded in photographic emulsion. M. DANYSZ. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 5, 177–8 (1953).

Two tracks at 128° (680 and 13 000 μ long), originating at a point, can be interpreted as $V_1^0 \rightarrow$ in flight $\rightarrow \pi^- + p + (35{\cdot}5 \pm 2)$ MeV. W. J. SWIATECKI

539.18

541. On the χ–μ decay-in-flight in the photographic emulsion exposed at high altitude. K. NIU. Letter in *Progr. theor. Phys.*, **11**, *No.* 4–5, 499–500 (*April–May*, 1954).

Discusses a star observed in G5 emulsion and consisting of two thin tracks, a black track and a grey track. The grey track shows an abrupt decrease in grain density at a distance of approximately 3500 μ from the star and is attributed to a χ-meson which decays in flight. H. ELLIOT

539.18

542. Analysis of two *K*-events. D. HIRSCHBERG AND L. HIRSCHBERG. Letter in *Nuovo Cimento*, **12**, *No.* 2, 296–9 (*Aug.*, 1954) In French.

The decay of two *K*-mesons was observed in a stack of nuclear emulsions. Their modes of decay are discussed and values of the masses are given. J. HUGHES

539.18

543. Decay at rest of a particle with mass of a hyperon. C. CASTAGNOLI, G. CORTINI AND A. MANFREDINI. Letter in *Nuovo Cimento*, **12**, *No.* 3, 464–5 (*Sept.*, 1954) In Italian.

An event has been found in a stack of stripped emulsion, in which a particle (whose mass is $2800^{+1500}_{-900} m_e$ from scattering measurements, or $2670 \pm 500 m_e$ from gap counts) emerges from a star, and on coming to rest produces a particle whose mass is certainly greater than that of a π-meson. This event is interpreted as $Y^+ \rightarrow P + \pi^0 + Q$, $Q = 117 \pm 1{\cdot}3$ MeV. A κ-meson has also been identified among the star prongs, giving further evidence that hyperons and κ-mesons are often produced in association in high-energy stars. P. ROTHWELL

539.18

544. Radiative decay of the θ° particle. S. B. TREIMAN. Letter in *Phys. Rev.*, **95**, *No.* 5, 1360–2 (*Sept.* 1, 1954).

The distribution in apparent *Q*-values due to radiative decay is calculated on standard theory. In the normal mode of decay ($\theta^\circ \rightarrow \pi^+ + \pi^- + Q$), *Q* is 214 ± 5 MeV; the probability that the apparent *Q*-value is less than 194 is found to be 7×10^{-3}. L. PINCHERLE

539.18 : 537.531

545. Limits on π^--meson mass from mesonic X-rays. M. STEARNS, M. B. STEARNS, S. DEBENEDETTI AND L. LEIPUNER. Letter in *Phys. Rev.*, **95**, *No.* 5, 353–4 (*Sept.* 1, 1954).

By placing 1 cm thick cells containing absorbers of elements with $Z = 57, 58, 59, 60$ between the source of the X-rays and a NaI detector with the concentration adjusted to transmit energies just below the *K*-absorption edge, a discontinuity in the transmitted intensity was observed between $Z = 58$ and 59. This brackets the mass to $272{\cdot}7 m_e \leqslant m_{\pi^-} \leqslant 273{\cdot}6 m_e$. W. J. SWIATECKI

539.18

546. Precision measurement of the negative pion mass from its radiative absorption in hydrogen. K. M. CROWE AND R. H. PHILLIPS. *Phys. Rev.*, **96**, *No.* 2, 470–83 (*Oct.* 15, 1954).

The γ-ray spectrum of the reaction $\pi^- + p \rightarrow n + \gamma$ has been remeasured with an improved design of the high-energy pair spectrometer. This design has taken advantage of one of the focusing properties of a 90-degree wedge-shaped magnetic field to minimize the effect on the resolving power of multiple scattering of the pair fragments in the convertor. The theory of the spectrometer is developed in detail. The accuracy of the energy scale depends on magnetic field measurements and the calculation of orbits, aberrations and resolving power. By the determination of the mesonic absorption γ-ray energy, a precise mass value for the negative pion has been found: $M_{\pi^-} = 272{\cdot}7 \pm 0{\cdot}3 m_e$. From the $\pi^- - \pi^0$ mass differences already obtained by Panofsky, Aamodt, and Hadley (PAH), by Chinowsky, Sachs, and Steinberger (CSS), and the $\pi^- - \mu^-$ mass difference obtained by Lederman, Tinlot, and Booth (LTB), it is possible to improve the mass values for the π^0 and the μ^- mesons. From $\pi^- - \pi^0$ (PAH): $M_{\pi^0} = 262{\cdot}2 \pm 2{\cdot}0 m_e$; from $\pi^- - \pi^0$ (CSS): $M_{\pi^0} = 263{\cdot}9 \pm 0{\cdot}7 m_e$; from $\pi^- - \mu^-$ (LTB): $M_{\mu^-} = 206{\cdot}7 \pm 3{\cdot}0 m_e$. If one assumes that the positive and negative pions have the same mass, the mass of the positive muon can also be deduced from the work of Birnbaum, Smith, and Barkas: $M_{\mu^+} = 206{\cdot}3 \pm 0{\cdot}3 m_e$. A.

539.18

547. Photoproduction of mesons in the theory of radiation damping. V. MIKHAÏLOV AND A. BALDIN. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 5, 613–15 (1953) In Russian.

The usual perturbation theory [Abstr. 1221 (1952)] predicts an approximately isotropic distribution of π^0 mesons, in contradiction with experiment. Calculations are carried through here with a symmetrical pseudoscalar coupling ($g^2/\hbar c \sim 1$) and yield results which are qualitatively in agreement with the experimental distribution, without destroying the previous agreement for the production of π^+ mesons. G. E. BROWN

539.18

548. An unstable fragment and a positive τ-meson emitted in a nuclear disintegration. A. DEBENEDETTI, C. M. GARELLI, L. TALLONE AND M. VIGONE. Letter in *Nuovo Cimento*, **12**, *No.* 3, 466–9 (*Sept.*, 1954).

Discusses an example of the decay at rest of an unstable fragment ejected from a star observed in a stack of stripped emulsions. It is shown that the event can be interpreted as the decay of an excited $_1H^3$ nucleus according to the scheme $_1H^{3*} \rightarrow {}_2He^3 + \pi^- + (42{\cdot}06 \pm 4{\cdot}2)$ MeV. A positive τ-meson is emitted from the same star and decays in the emulsion. The two positive π-mesons suffer $\mu \rightarrow e$ decay and the negative one gives rise to a two-pronged star. The Q value for the decay is $71{\cdot}4 \pm 3{\cdot}2$ MeV.

H. ELLIOT

539.18

549. Tau meson produced by 3·0 BeV protons. R. D. HILL, E. O. SALANT AND M. WIDGOFF. Letter in *Phys. Rev.*, **95**, *No.* 6, 1699–700 (*Sept.* 15, 1954).

Ten stopping K-mesons and one τ-meson have been found in a stack of emulsions exposed at 90° to a 3·0 BeV proton beam. The initial energy of the τ-meson is estimated as 122 MeV. Energy considerations lead to the conclusion that it is unlikely that this meson was produced in a single nucleon-nucleon interaction, paired with another K-meson.

P. ROTHWELL

539.18 : 539.166.2

550. Radiation of γ-rays upon collision of fast π-mesons with nucleons. L. D. LANDAU AND I. YA. POMERANCHUK. *Zh. éksper. teor. Fiz.*, **24**, *No.* 5, 505–15 (1953) In Russian.

The bremsstrahlung of γ-rays is calculated for π-mesons which are absorbed by a "black" nucleon and, therefore, produce diffraction scattering. For large energies, $E \gg \mu$, where μ is the π-meson rest energy, it is shown that only the region outside the nucleon contributes appreciably to this process, and the π-meson wave-function is known in this region as a sum of plane waves and diffracted waves. Radiation accompanying the capture of the π-meson is also calculated. The differential cross-section for radiation is found to be small compared to πR^2 except for small angles, $\theta < \mu/E$, where it becomes large with increasing energy.

G. E. BROWN

539 18

551. On the scattering of π-mesons by nucleons. V. P. SILIN. Letter in *Zh. éksper. teor. Fiz.*, **25**, *No.* 2(8) 255–6 (1953) In Russian.

The experimental data for the scattering of mesons in the $S_{\frac{1}{2}}$ state determine only two parameters (scattering length a and range of force r_0) in a phenomenological theory. With a particular choice of $a = 0{\cdot}3\hbar/\mu c$ and $r_0 = 1{\cdot}05\hbar/\mu c$, agreement with experiment is obtained.

G. E. BROWN

539.18

552. Kinematical studies of pion-nucleon interactions. S. HAYAKAWA, M. KAWAGUCHI AND S. MINAMI. Letter in *Progr. theor. Phys.*, **11**, *No.* 3, 332–3 (*March*, 1954).

It is suggested that the degeneracy in the cross-section for pion-nucleon scattering referred to in Abstr. 8914 (1954) may be removed by observing the polarization of the recoil nucleons. Expressions for the polarization in terms of phase shifts for states up to $J = 3/2$ are given.

G. FIELD

539.18

553. Meson-meson interaction in meson scattering. M. ROSS. Letter in *Phys. Rev.*, **95**, *No.* 6, 1687–9 (*Sept.* 15, 1954).

The low-energy meson-nucleon scattering data are discussed on the assumption that it is due to a meson-nucleon interaction and a direct interaction between the scattered meson and the mesons of the nucleon proper field.

P. T. MATTHEWS

539.18 : 537.533.74

Scattering of electrons by mesons. *See Abstr.* 326

539.18 : 530.145

554. On the magnetic moment of the neutrino. G. F. ZHARKOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 5, 529–36 (1953) In Russian.

The magnetic moment arising from the self-energy (which comes from the coupling used in β-decay between the neutrino, electron and nucleon fields) is calculated to lowest order. The expressions are infinite unless the integrands are cut off. This is done at a point which is determined by making the self-mass of the neutrino less than the highest limit set on it by experiment. It is then found that μ_ν/μ_e, the ratio of the neutrino to electron magnetic moment, is $\sim -10^{-14}$.

G. E. BROWN

539.185

555. On the neutron He⁴ scattering. T. TAMURA. Letter in *Progr. theor. Phys.*, **11**, *No.* 3, 335–6 (*March*, 1954).

A preliminary report of a calculation done by the method of resonating group structures. It seems possible to obtain negative s-phases and positive p-phases.

G. E. BROWN

539.185 : 538.221

556. Time-dependent correlations between spins and neutron scattering in ferromagnetic crystals. L. VAN HOVE. *Phys. Rev.*, **95**, *No.* 6, 1374–84 (*Sept.* 15, 1954).

The pair correlation between spins considered at different times in a ferromagnetic crystal is used to derive a general formula for the angular and energy distribution of magnetically scattered neutrons. The qualitative properties of the correlation are established for various temperature ranges and a number of characteristic features of the scattering and of its temperature variation are thus accounted for. From the study of the long-range part of the correlation an explicit expression is derived for the "critical magnetic scattering" produced in the neighbourhood of the Curie point by the large spontaneous fluctuations of the magnetization.

A.

539.185

557. The influence of hindered rotation on the scattering of slow neutrons by bound protons. W. KOŁOS. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 2, 63–7 (1954).

The type of proton considered is bound to a part of a molecule which prefers to orient itself in a particular direction with respect to the remainder. Cross-sections are calculated for inelastic scattering processes

in which rotational oscillations around this preferred direction are excited or de-excited. In particular the scattering of slow neutrons by methyl alcohol is discussed. J. M. CASSELS

539.185

558. The neutron absorption cross sections of U^{238} and U^{235} at 2200 m/sec. P. A. EGELSTAFF. Letter in *J. nuclear Energy*, **1**, *No.* 1, 92 (*Aug.*, 1954).

Values of $2{\cdot}8 \pm 0{\cdot}1$ barn for U^{238} and 720 ± 15 barn for U^{235} were obtained by transmission experiments using a slow neutron chopper.

J. M. CASSELS

539.185.08

559. A time-of-flight neutron spectrometer. P. E. TRIER, J. C. HAMMERTON AND E. WOLFENDALE. *Philips tech. Rev.*, **15**, *No.* 12, 325–40 (*June*, 1954).

A description is given of a spectrometer installed in the Atomic Energy Research Establishment at Harwell and used for measurements of the energy levels of neutron scattering and resonance absorption. The heart of the installation is the 15 MeV linear accelerator which has been previously described. A 2 μsec electron pulse after travelling down the accelerator is used to irradiate a γ-ray and neutron source. Some of the liberated neutrons travel down a 20 m flight path, after which they have become spaced out in time according to their energies. The installation contains two of these flight paths, which can be used separately for independent experiments. At the end of each flight path the neutrons are detected by a neutron detector. The electrical signal pulses from this chamber constitute a series whose distribution in time corresponds to the energy spectrum. This pulse series is fed to the input rail of a bank of 100 gating units, which are opened successively for equal short intervals ΔT starting with a time delay T from the initiation of the neutron pulse. Each gating unit output is fed to a mechanical counter. The intervals ΔT can be set at 2 or 10 μsec and the delay time T is adjustable between 0 and 2990 μsec. The principal recurrence frequency can at present be set at 200 or 400 c/s. Some calculations are made concerning the accuracy and the reliability of the installation and a short description is given of some constructional details. A.

539.185.08

560. Fast-neutron dose in a large tissue-equivalent phantom. T. A. BARR AND G. S. HURST. *Nucleonics*, **12**, *No.* 8, 33–5 (*Aug.*, 1954).

Experiments were carried out with a tissue equivalent mixture (urea–sugar–water) in a tank 30 cm deep by 2 m dia. with a homogeneous ethylene ionization chamber, to measure the fast-neutron dosage, at various depths in the mixture, produced by a Po–B source. The experimentally determined dose rates were in fairly good accord with those calculated by Snyder and Neufold. L. R. SHEPHERD

539.185.08

561. Fast-neutron scattering: A correction for dosimetry. J. W. CURE AND G. S. HURST. *Nucleonics*, **12**, *No.* 8, 36–8 (*Aug.*, 1954).

Experiments were carried out to determine the importance of neutrons scattered from a concrete floor on dose rates measured in a homogeneous ethylene-filled ionization chamber set at various horizontal distances from a Po–B source, the height of source and detector above the floor also being varied. Results were in good agreement with albedo theory calculations. L. R. SHEPHERD

STRUCTURE OF SOLIDS 539.2

539.211 : 535.822.9

Application of two-beam interference microscope to the study of surfaces. *See Abstr.* 239

539.211 : 778.33

562. Autoradiographic studies of surface detail with chromium-51. L. E. PREUSS. *Nucleonics*, **12**, *No.* 8, 30–2 (*Aug.*, 1954).

A radioactive metal film is evaporated obliquely on to the surface under investigation. The thickness of the deposit, revealed by autoradiography, shows the surface structure. Experiments with Cr^{51} evaporated on to Cu surfaces have resolved surface detail to better than 40 μ. L. R. SHEPHERD

539.217

563. The mechanism of diffusion of cathodic hydrogen into iron. M. ŚMIAŁOWSKI AND Z. SZKLARSKA-ŚMIAŁOWSKA. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 7, 327–31 (1953).

The degree of elongation of wires as a result of their saturation with cathodic H_2 [Abstr. 6028 (1954)] appears to depend principally upon the tensile strength of the wire. A marked brittleness of the saturated wires did not wholly disappear, nor did the wires contract at all, on removing the absorbed H_2. There is a direct relation between the degree of brittleness and the maximum expansion of the wire. From the known plastic properties of the wires and their observed extension by H_2 adsorption it is estimated that there is an effective pressure of H_2 at the surface well above 1400 atmospheres. Such pressures could occur within very tiny bubbles of H_2 formed at the surface of the Fe during electrolysis and might be responsible for driving the gas into the metal.

A. D. LE CLAIRE

539.217

564. On the question of the partial diffusion coefficients in metallic solid solutions. T. HEUMANN. Note in *Naturwissenschaften*, **41**, *No.* 14, 328 (1954) In German.

An earlier paper is corrected [see Abstr. 6248 (1953)] and now gives Darkens equations. The movement of the Matano interface is therefore related to direct observation of the interface. Much experimental work disagrees with theory, and a further paper will deal with the discrepancies. W. M. LOMER

539.217

565. The diffusion of carbon in alpha iron. W. R. THOMAS AND G. M. LEAK. Letter in *Phil. Mag.*, **45**, 986–7 (*Sept.*, 1954).

Using the same method as for Abstr. 8693 (1954), the diffusion coefficient D was found to be $D = 3{\cdot}16 \times 10^{-2} \exp(-20\,400/RT)$ cm^2/sec. A. D. LE CLAIRE

539.217

566. A precision grinding machine for diffusion studies. H. Letaw, Jr, L. M. Slifkin and W. M. Portnoy. *Rev. sci. Instrum.*, **25**, *No.* 9, 865–8 (*Sept.*, 1954).

A precision grinding machine was constructed to permit the study of diffusion in germanium. Because one may obtain data after mean penetrations of the order of 10 μ, this instrument is useful for problems involving very small diffusion coefficients and radioactive tracers of very short half-life. It has been found that diffusion in ductile metals such as silver may be investigated by use of this technique. A.

539.234

567. Electron beam effects on thin evaporated bismuth films. P. J. Bryant, H. U. Rhoads and H. A. Weber. Letter in *J. appl. Phys.*, **25**, *No.* 10, 1343–4 (*Oct.*, 1954).

It is suggested that the action of an electron beam on Bi films is to enhance Bi aggregation by extremely localized melting, evaporation and recrystallization.

C. A. HOGARTH

539.27

568. Effects of unidirectional rubbing of cupric oxide formed anodically. A. Goswami. Letter in *J. sci. industr. Res.*, **13 B**, *No.* 8, 581–2 (*Aug.*, 1954).

Discusses the effect of rubbing with cotton wool on the preferential orientation of crystals of CuO, as revealed by electron diffraction observations.

J. THEWLIS

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31 : 536.7

569. Thermodynamic theory of elastic relaxation. J. Meixner. *Z. Naturforsch.*, **9a**, *No.* 7–8, 654–63 (*July–Aug.*, 1954) In German.

The properties of viscoelastic systems with any number of external variables undergoing relaxation are studied under the assumption that relaxation phenomena can be described through internal variables with the aid of the thermodynamics of irreversible processes. Proofs are given of certain properties of the relaxation matrix, thermodynamic potentials, and relaxation spectra. The theory can be equally well applied to the case of dielectric relaxation.

A. GELBTUCH

539.31 : 536.7

Thermodynamical extension of the theory of after-effects [viscoelasticity]. *See Abstr.* 265

539.32 : 534.21

570. An approximation method for the determination of the elastic constants of single crystals. J. R. Neighbours. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 865–9 (*Sept.*, 1954).

Plane elastic waves travelling in an arbitrary direction in a crystal are, in general, neither transverse nor longitudinal and in fact show polarization angles up to 11° in nickel. A method for deducing the elastic constants of a cubic crystal is well known. The method is here extended to other crystal classes where the method may be used in order to deduce all the elastic constants of a crystal. A.

539.32 : 537.226.2/.3 : 621.3.011.5 : 621.315.616.9

The dynamic mechanical behavior of polymethyl methacrylate. *See Abstr.* 275

539.32 : 537.312.62

571. Elastic moduli of tin at the superconducting transition. J. K. Landauer. *Phys. Rev.*, **96**, *No.* 2, 296–301 (*Oct.* 15, 1954).

A composite oscillator technique was used to measure the elastic moduli of tin in the normal and superconducting states. The experiments were performed on single crystals at about 50 kc/s. A difference in moduli was observed, indicating that the velocity of sound is less in the superconducting than in the normal state. At 3·7°K the relative change at the superconducting transition is about 4 parts in 10^6 for the longitudinal modulus S_{11} and about 6 parts in 10^6 for the torsional modulus, $2(S_{44} + S_{66})$. These relative changes increase with decreasing temperature. At room temperature, the adiabatic modulus S_{11} was found to be $1{\cdot}55 \times 10^{-12}$ cm²/dyne, and $2(S_{44} + S_{66})$ was $9{\cdot}4 \times 10^{-12}$ cm²/dyne. A.

539.32 : 541.64

572. Elastoviscous properties of amorphous polymers in the transition region. II. Stress-relaxation of butadiene-styrene copolymers. E. Catsiff and A. V. Tobolsky. *J. appl. Phys.*, **25**, *No.* 9, 1092–7 (*Sept.*, 1954).

For Pt I, see *J. Amer. Chem. Soc.*, **74**, 3378 (1952). Experimental data have been obtained on the stress-relaxation modulus $E_r(t)$ of several copolymers in their transition regions. The new data are expressed as master curves which can be fitted to the Gauss Error Integral form of reduced equation, as previously proposed. It appears possible to characterize the time and temperature-dependence of E_r of amorphous polymers in general by means of the parameters of this equation: E_1 (glassy-state modulus), E_2 (rubbery-state modulus), T_d (distinctive temperature, related to second-order transition temperature), K_d (characteristic relaxation time at T_d) and h (parameter related to steepness of master curve). In the butadiene-styrene series, the effect of composition on these parameters has been determined. A.

539.501 : 541.182.6

573. The rheology of suspensions. K. H. Sweeny and R. D. Geckler. *J. appl. Phys.*, **25**, *No.* 9, 1135–44 (*Sept.*, 1954).

The rheological properties of concentrated suspensions of sized glass spheres in an equal-density medium has been investigated with the rotational viscosimeter. It has been found that the variation of fluidity with rate of shear can be expressed satisfactorily by a form of an expression suggested by Reiner relating the fluidity to the shearing stress, the fluidity at rest and the fluidity at infinite shearing stress. It is also shown that values of the apparent fluidity are influenced by the time of shearing, the ageing of the suspensions, and temperature effect attributed to the work of shearing. The viscosity of suspensions of sized spheres at concentrations as great as 55 vol.% solids may be satisfactorily represented by either the relation of Mooney or of Maron, Madow and Krieger; the identity of

their relations is also shown. The constants for the equation relating viscosity and concentration are shown to be in satisfactory agreement with those predicted by Mooney. Constants for the viscosity-concentration equation are also given for several examples of experimental work selected from the literature; the form of equation proposed by Mooney relating viscosity and concentration is generally useful though the constants may not agree with the predicted values. It has been found that the apparent fluidity of the glass bead suspensions decreases with an increase in particle diameter when the suspending fluid is zinc bromide in aqueous glycerol though the viscosity is independent of particle diameter when the suspending fluid is the nonaqueous mixture of ethylene tetrabromide and diethylene glycol. The viscosity of a bimodal system of glass beads was shown to decrease very significantly as the bulk density was increased by packing progressively smaller spheres into the interstices of the larger spheres of the bimodal system, in qualitative agreement with a relation proposed by Mooney. A.

539.56

574. Influence of deuteron bombardment and strain hardening on notch sensitivity of mild steel. R. A. MEYER. *J. appl. Phys.*, **25**, *No.* 11, 1369–74 (*Nov.*, 1954).

Schnadt-type impact specimens of SAE 1019 steel were irradiated with 18·6 MeV deuterons for the purpose of studying the influence of radiation on the brittle property as measured by the change in transition temperature. The effect was compared with that of 2, 5 and 10% strain hardening. Microhardness studies were made to determine the extent and location of the radiation effect. An integrated flux of 29·6 μA-hr per cm^2 shifted the transition temperature from −1°c to 18°c. The embrittling action was not a linear function of dose. Hardness was increased from 180 to 380 Knoop numbers. It was found to depend on the depth of penetration as well as the integrated flux. While radiation caused an effect similar to strain hardening, the nature of this effect was different. Annealing studies showed recovery of the irradiated material occurred between 260°c and 480°c. An interstitial vacancy diffusion process was indicated. Activation energies increased as recovery progressed. Recovery of the 5% strain-hardened material occurred between 315°c and 371°c and would appear to be relaxation of internal stresses by the movement of dislocations. A.

539.622

575. The mechanism of rolling friction. D. TABOR. Letter in *Phil. Mag.*, **45**, 1081–4 (*Oct.*, 1954).

Earlier experiments [Tabor, Abstr. 1996 (1953)] on rolling of hard spheres on rubber suggested that main resistance to rolling arises from elastic hysteresis losses in rubber. Observations have been extended to metals, using a ball rolling over an identical ball in order to eliminate effects due to interfacial slip. Rolling resistance is found to be the same as that of ball rolling in equilibrium groove on flat surface, and resistance is unaffected by boundary lubricant. It is deduced that rolling resistance is due to hysteresis losses and that loss factor lies between 1 and 2% for a wide variety of materials, work hardened copper, ball race steel, work hardened mild steel, phosphor bronze and duralumin, when strained cyclically to a point just within the elastic limit, and is proportionately less for a smaller strain. After prolonged rolling, material in groove begins to deteriorate as result of fatigue. Use of lubricant probably extends life by reducing surface attrition but has no appreciable effect on friction. J. W. MENTER

539.893 : 548.73

576. Contribution to the X-ray crystallographic study of allotropic transformations induced by pressure. L. GUENGANT AND B. VODAR. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 5, 431–3 (*Aug.* 2, 1954) In French.

The specimens were contained under pressure in a tube made of a single crystal of beryllium [see also Abstr. 2167 (1951)]. Photographs of KNO_3 and AgI at 4000 kg/cm^2 are reproduced. A. R. STOKES

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.117

577. The stabilization of methyl radical. I. L. MADOR. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1617 (*Sept.*, 1954).

Methyl radicals were produced by photolysis of CH_3I and X-radiation and pyrolysis of $Pb(CH_3)_4$. The absorption spectrum was taken. Photolysis of CH_3I at 4°K produced bands due to CH_4, C_2H_4, C_2H_6 and CH_2I_2. At 30° to 40°K the films disintegrated. This can be explained by exothermic radical recombination reactions. Irradiation of $Pb(CH_3)_4$ also produced CH_4; pyrolysis of $Pb(CH_3)_4$ produced CH_4, C_2H_6, C_2H_4 and C_3H_8. A. J. TAYLOR

541.117

578. Stabilization of free radicals from the decomposition of hydrazoic acid. I. L. MADOR AND M. C. WILLIAMS. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1627–8 (*Sept.*, 1954).

HN_3 was decomposed by an electric discharge and the products frozen out at 4° and 77°K. The infrared spectrum of the blue solid formed was taken and showed a considerable amount of HN_3. The spectrum showed bands belonging to NH_4N_3 and bands at 3500 Å and 6500 Å, which may be due to NH and NH_2 radicals. Decomposition of HN_3 at 77°K without discharge gave a colourless gas which became polycrystalline at 148°K. After this transformation the NH and NH_2 bands had disappeared. A. J. TAYLOR

541.123.1

579. The liquid system ozone–oxygen. A. C. JENKINS AND C. M. BIRDSALL. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1779 (*Oct.*, 1954).

Contrary to the findings of Schumacher [Abstr. 830 (1954)] no ozone–oxygen azeotrope could be found

over the whole composition range from 3·5 mole-% ozone to nearly 100%. Schumacher's method of vaporizing the entire ozone-rich sample before analysis may have produced decomposition of the ozone, yielding low results, and it is also suggested that precautions to assure temperature equilibrium between the resistance thermometer and sample bulb, in Schumacher's experiments, may have been inadequate.

R. C. MURRAY

541.124

580. Chemical kinetics and equilibrium. The law of integral powers in kinetics. J. A. CHRISTIANSEN. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1612 (*Sept.*, 1954).

Three principles are stated: (1) equilibrium conditions must be derived from kinetics; (2) the powers of concentrations in expressions for the velocity of reactions are always integral; (3) microscopic reversibility. These show that the reaction rate for a reaction taking place in steps must be: $s_2 = F(p_+ - p_-)$, which can be used according to Hinshelwood *et al.* [Abstr. 436 (1947)] for determining the backward rate of a reaction from the forward rate. See also abstract following.

C. TURNER

541.124

581. Reply to Christiansen's letter, "Chemical kinetics and equilibrium." M. MANES, L. J. E. HOFER AND S. WELLER. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1612–13 (*Sept.*, 1954).

Christiansen's equation (preceding abstract) does not yield the equation of Abstr. 436 (1947), $g_f/g_b = p_+/p_-$. To get this an extra condition, not included in Christiansen's derivation, must be satisfied. Christiansen's statement (3) does not exclude fractional exponents for p_+ and p_-.

C. TURNER

541.124 : 541.51

582. Methyl affinities of aromatic compounds. M. LEVY AND M. SZWARC. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1621–2 (*Sept.*, 1954).

Methyl radicals can be captured by aromatic compounds, forming new radicals; the relative methyl affinities of different aromatics can be defined and measured with reference to the thermal decomposition of diacetyl peroxide (generating CH_3 radicals) in iso-octane solution, also containing the aromatic compound. This yields CO_2, C_2H_6 and an amount of CH_4 which is decreased by the presence of the aromatic. The relative methyl affinity is defined as the ratio of the rate constants of the competing reactions of CH_3 with the aromatic and with the iso-octane, and is equal to the ratio of the loss of CH_4 due to the aromatic to the amount actually formed. This ratio is nearly independent of the amount of aromatic present. It increases with increasing conjugation, e.g. from diphenyl ether (2·5) to diphenyl (11), as compared to benzene (1).

J. HAWGOOD

541.126

583. Some detonation properties of acetylene gas. R. E. DUFF, H. T. KNIGHT AND H. R. WRIGHT. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1618–19 (*Sept.*, 1954).

1 to 3 g of tetryl is found to initiate a stable detonation wave in acetylene at an initial pressure of 60 cm Hg. The initial part of the wave is observed to spin. The (high) spin-pitch to tube-diameter ratio varies from 3·4 to 4·0 depending on the dia. of the tube. A study of the stability of the detonation revealed that the wave does not fail even in tubes as small as 13 mm int. dia. In a 25 mm tube a non-luminous shock wave precedes the luminous zone by a constant distance of about 90 mm.

W. GOOD

541.126

584. Application of the Hertz theory of impact to explosion phenomena. M. P. MURGAI. *J. chem. Phys.*, **22,** *No.* 10, 1687–9 (*Oct.*, 1954).

Pressure and time of impact have been calculated by Hertz theory of impact, taking data from some experiments on explosion. The calculated temperature rise, by adiabatic compression of an entrapped gas bubble, is within a reasonable range of that obtained experimentally. The calculated times have been compared with experimental observations on impact explosion delays. The adiabatic compression of solids has been referred to.

A.

541.126

585. Improved approximate solutions of flame equations for flames governed by simple chemical reactions. K. A. WILDE. Letter in *J. chem. Phys.*, **22,** *No.* 10, 1788 (*Oct.*, 1954).

An improvement on Adams' (1949) method of integrating the eigenvalue equation for flame speed of a one-dimensional flame governed by a first-order reaction is presented: the agreement of dimensionless flame speeds calculated from the equation developed, with those derived by Friedman and Burke [Abstr. 4441 (1953)] by numerical integration, is ±2%, within the limits of error of the numerical integration.

R. C. MURRAY

541.126

586. Spontaneous ignition of an inflammable gaseous mixture on release from compression. W. C. F. SHEPHERD. Letter in *Nature* [*London*] **174,** 658–9 (*Oct.* 2, 1954).

Very violent explosions occurred when lean methane-oxygen mixtures were suddenly released from a container into a tube open at the far end, by the bursting of a diaphragm through gradual build up of the pressure inside the chamber. The pressure at which the disk must rupture in order to ensure explosion increases as the tube length decreases, but explosions are obtained in discharge into free air (tube length = 0) from a pressure of 1000 lb/in^2. These results may explain some anomalous results observed by Hertzberg and Smith [Abstr. 3209 (1954)] with shock tubes.

R. C. MURRAY

541.127

587. A quantum-mechanical equation of reaction rates. I. YASUMORI AND K. FUEKI. Letter in *J. chem. Phys.*, **22,** *No.* 10, 1790–1 (*Oct.*, 1954).

The eigenfunctions of the wave equation describing the reaction A + BC → AB + C of linear configuration are expanded in terms of the vibrational eigenfunctions of the BC molecule. The set of simultaneous differential equations satisfied by the expansion coefficients is given; it can be solved approximately under special conditions, or exactly if atom A experiences an Eckart potential. In the latter case the transmission coefficient can be calculated and hence the rate equation obtained. At high temperatures this becomes the equation of absolute reaction

rate theory. This is illustrated by a table of the ratio of the calculated rates of the reaction $H + H_2 \rightarrow H_2 + H$ as a function of temperature. A. J. TAYLOR

ELECTROCHEMISTRY 541.13

541.13 : 537.36 : 541.18.045

588. Separation and concentration of proteins in a pH field combined with an electric field. A. KOLIN. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1628–9 (*Sept.*, 1954).

A description is given of the cell in which by maintaining a field of varying H^+ concn. in a solution traversed by an electric current it has been found possible to make ampholytes converge from both sides towards points at which the pH is equal to the isoelectric pH of the ampholyte. Concentration and dilution effects with hemoglobin and the separation of hemoglobin from cytochrome C are illustrated. The phenomena were also observed using filter-paper electrophoresis techniques. W. GOOD

541.135.5

589. Calculation of the concentration of atomic hydrogen at a cathode. II. H. W. SALZBERG AND S. SCHULDINER. Letter in *J. chem. Phys.*, **22,** *No.* 10, 1774 (*Oct.*, 1954).

Bockris and Parsons' criticism [Abstr. 4446 (1953)] of the authors' calculation [Abstr. 510 (1953)] of the concentration of atomic hydrogen at a cathode is contested, the previous results claimed to be correct, and the equation of Bockris *et al.* [Abstr. 6846 (1952)] stated to be still incorrect on the grounds of the omission of a probability term, a limitation of the choice of standard states and the mechanism proposed for hydrogen evolution on Pt at high current densities. See also abstract following. H. H. HODGSON

541.135.5

590. Calculation of the concentration of atomic hydrogen at a cathode. II. J. O'M. BOCKRIS AND R. PARSONS. Letter in *J. chem. Phys.*, **22,** *No.* 10, 1774 (*Oct.*, 1954).

In a reply to Salzburg and Schuldiner (preceding abstract), it is noted that these authors have withdrawn their contention that the dimensions of the equation [Abstr. 6846 (1952)] are incorrect, and also have conceded the error in their own equation. The remaining three differences in dispute are discussed, and it is pointed out that the probability factor is only required when the adsorbed atoms are immobile, that any standard states may be used in the reaction rate theory, that their correspondence to physical reality is not of moment, and that the electrochemical mechanism previously proposed remains the most probable one. H. H. HODGSON

541.135.5 : 539.155.2

591. The isotope effect in the electrolytic migration of copper ions in molten cuprous chloride. A. LUNDÈN AND E. BERNE. *Z. Naturforsch.*, **9a,** *No.* 7–8, 684–9 (*July–Aug.*, 1954) In German.

Molten CuCl was electrolysed in the chain: carbon (cathode) + $Cl_2|LiCl + KCl||CuCl||PbCl_2|$carbon (anode) + Cl_2. Enrichment of Cu^{65} relative to Cu^{63} was found at the boundary between the molten CuCl and $PbCl_2$. The relative difference of the migration velocities of the isotopes was estimated to be 0·0025, and the mass effect, μ (by calc.) — 0·080. The latter agrees with a formerly proposed rule [Abstr. 1216 (1953)]. W. GOOD

541.135.6

592. Cell for measurement of polarization voltages in melted electrolytes. R. PIONTELLI AND G. MONTANELLI. Letter in *J. chem. Phys.*, **22,** *No.* 10, 1781–2 (*Oct.*, 1954).

A description is given of the construction of a cell which has given excellent results in the measurement of overvoltages on lead electrodes in melted lead chloride. W. GOOD

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

593. Photolysis of mixtures of acetone-d_6 and diethyl ketone. M. H. J. WIJNEN. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1631 (*Sept.*, 1954).

A reaction mechanism for the photolysis is proposed and found to agree with experimental results. W. GOOD

541.14

594. Vacuum ultraviolet photochemistry. I. Nitrous oxide at 1470 Å. M. ZELIKOFF AND L. M. ASCHENBRAND. *J. chem. Phys.*, **22,** *No.* 10, 1680–4 (*Oct.*, 1954).

The photolysis of nitrous oxide at 1470 Å has been studied and the quantum yields measured for N_2O disappearance and NO, O_2 and N_2 appearance. The average of 38 measurements gives $\phi N_2O = 1{\cdot}7_0$, $\phi O_2 = 0{\cdot}5_0$ and $\phi N_2 = 1{\cdot}4_4$ with ϕNO being pressure dependent. The data obtained here can be explained by a mechanism involving initial dissociation of nitrous oxide into nitrogen molecules and oxygen atoms. The source of NO can be in the reaction $O + N_2O \rightarrow 2NO$. These results are discussed in the light of previous work. A.

541.14

595. Vacuum ultraviolet photochemistry. II. Nitrous oxide at 1849 Å. M. ZELIKOFF AND L. M. ASCHENBRAND. *J. chem. Phys.*, **22,** *No.* 10, 1685–7 (*Oct.*, 1954).

The photolysis of nitrous oxide at 1849 Å has been studied and the quantum yield ratios $\phi N_2O/\phi N_2$, $\phi N_2O/\phi O_2$ and $\phi N_2O/\phi$NO measured. The former two ratios compare well with the same ratios at 1470 Å and the latter ratio is pressure dependent. It appears that the photolysis mechanism at 1849 Å is similar to that at 1470 Å. The absorption coefficient of N_2O is calculated from the photolysis data and found to compare well with previous work. A.

541.14

596. Oxidation ions in hydrocarbons on ultraviolet irradiation. A. GEMANT. *J. chem. Phys.*, **22,** *No.* 10, 1705–9 (*Oct.*, 1954).

Ultraviolet irradiation, mostly in the presence of a peroxide, increases the electrical conductivity, thus produces oxidation ions in solutions of aromatic diols, to a lesser extent in those of monohydroxyl compounds, and to a still lesser, but measurable, extent in a

hydrocarbon itself, namely *o*-xylene. Ultraviolet spectroscopy permits identification of the chief oxidation products: *o*-phthalic aldehyde in the case of *o*-xylene. The ions are probably oxidation intermediates of relative stability. Whereas the anion can be derived from the acids, the cations are probably oxonium-type ions, derivable from the *o*-aldehydes formed. A.

541.14

597. Photochemical reactions of cyclo-octatetraene. I. TANAKA AND M. OKUDA. Letter in *J. chem. Phys.*, **22,** *No.* 10, 1780–1 (*Oct.*, 1954).

Among the products of the photochemical decomposition of cyclo-octatetraene, benzene, acetylene and styrene have been identified and their quantities determined by means of a mass spectrometer. It is shown that benzene and acetylene are produced in the same reaction process. W. GOOD

541.14 : 535.343.2

Photochemistry of silver halide crystals with sulphur, selenium and tellurium additions. *See Abstr.* 181

541.14 : 539.155.2 : 551.510.41

598. The relative abundance of HT and HTO in the atmosphere. P. HARTECK. *J. chem. Phys.*, **22,** *No.* 10, 1746–51 (*Oct.*, 1954).

A kinetic discussion of the HT and HTO formation in the atmosphere indicates that the ratio of about 1 HT to 1000 HTO in nature and the very high T concentration of 4×10^{-15} in atmospheric hydrogen compared with about 3×10^{-18} in normal rainwater can only be understood by means of a photochemical reaction. Since the tritium atoms are quickly removed by oxygen molecules in three-body collisons and form the TO_2 radical which in turn forms HTO, the TO_2 must be photochemically dissociated. The T atoms thus set free collide repeatedly with hydrogen atoms and undergo to a certain extent the exchange reaction $H_2 + T = HT + H$. On the other hand, the T atoms or TO_2 radicals may react with ozone to form an OT radical which combines with the hydrogen of the atmosphere into HTO. In low altitudes the reaction of TO_2 with air-polluting bodies forms HTO predominantly. The ratio of these reactions is responsible for the ratio of HT and HTO in nature with the HTO brought down into the surface waters by rainfall. A.

541.15

599. Electron irradiation of polythene. A. C. BASKETT AND C. W. MILLER. Letter in *Nature* [*London*] **174,** 364–5 (*Aug.* 21, 1954).

In polythene bombarded with electrons from a 4 MeV linear accelerator evidence of chain scission was obtained, but with a lower value for the limiting soluble fraction than that hitherto suggested. Molecular weight calculations based on the new data suggest that polyethylenes have wide molecular weight distributions. C. B. ALLSOPP

541.15

600. Radiation effects on reactor materials: metals. C. R. SUTTON AND D. O. LEESER. *Nucleonics*, **12,** *No.* 9, 8, 13–16 (*Sept.*, 1954).

Changes in mechanical properties of carbon- and stainless-steels, cobalt and nickel alloys, tungsten, tantalum and alloys of these, under irradiations of integrated neutron fluxes of 10^{19} to 10^{20} n/cm^2, are described and tabulated. Generally, there is an increase in hardness, tensile strengths, ductile-brittle transition temperatures and slight decreases in ductilities. L. R. SHEPHERD

541.15

601. Radiation effects on reactor materials: nonmetals. V. P. CALKINS. *Nucleonics*, **12,** *No.* 9, 9–12 (*Sept.*, 1954).

The mechanism of damage in nonmetallic materials, caused by γ-rays and heavy particles produced in neutron-induced reactions, is discussed. Results of measurements of increase of viscosity, gas evolution and other radiation-induced effects in various organic materials, which might be used in reactor construction, are given. L. R. SHEPHERD

541.15

602. Relative radiochemical efficiencies of mixed pile radiations and γ-rays. A. CHAPIRO. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 12, 703–5 (*Sept.* 20, 1954) In French.

Analysis of the results of irradiations of polymers in the Zoé (heavy water) pile by various workers leads to the result that for the total radiation a flux of 10^{17} n/cm^2 is equivalent to a dose of 7·5 to 11 Mr when the pile worked at 10 kVA, and to 4·5 to 8 Mr at 100 kVA. Corresponding values for BEPO (graphite pile) were 25 to 46 Mr. The γ-component is thus relatively more intense in the graphite pile. C. B. ALLSOPP

541.15

603. Pile irradiation of polyethylene terephthalate ("Terylene"). A. TODD. Letter in *Nature* [*London*] **174,** 613 (*Sept.* 25, 1954).

Results of irradiation of ethylene terephthalate polymers in the BEPO pile suggest that the effect, at least up to 800 MW hr, is degradative, possibly accompanied by branching. The solubilities in *o*-chlorophenol of all the samples used, unchanged by the irradiation, are inconsistent with any measure of cross-linking. C. B. ALLSOPP

541.15

604. Elementary processes in the radiation chemistry of water. K. J. LAIDLER. *J. chem. Phys.*, **22,** *No.* 10, 1740–5 (*Oct.*, 1954).

Schematic potential-energy diagrams are constructed for ground and excited states of H_2O, H_2O^+ and H_2O^-, making use of thermochemical, spectroscopic and electron-impact data. On electron impact a gaseous water molecule is raised to various states of H_2O, H_2O^+ and H_2O^-, which may subsequently decompose to give H, O, H_2 and OH and the ions H^+, H^-, O^+, O^-, OH^+ and H_2^+. The exact mechanisms by which these atoms, radicals and ions are produced are discussed in detail with reference to the potential-energy curves, due attention being paid to the appropriate correlation and selection rules. It is concluded that the production of O^- at 173 kcal electron energy probably proceeds via a $^2A_1$, $^2B_1$, $^2A_2$ or $^2B_2$ state of H_2O^- which decomposes into $2H + O^-$ without the prior formation of OH^-. The production of O^+ at 437 kcal must necessarily proceed via a $^4A_2$ or $^4B_2$ state of H_2O^+, while H_2^+ at 530 kcal must involve the formation of a $^2A_2$ or $^2B_2$ state; both these latter states are stable with respect to the simple breaking of an O — H bond. The nonappearance of

OH^- in electron-impact experiments is shown to be related to the high stability of OH^-, states of H_2O^- which correlate with $H + OH^-$ being of very high energy. The bearing of the treatment on the radiation chemistry of liquid water is briefly considered. A.

541.15 : 537.534.9

605. Cyclotron techniques for radiation damage studies. H. P. Yockey, A. Andrew, F. L. Fillmore, L. E. Glasgow, C. d'A. Hunt and J. H. Pepper. *Rev. sci. Instrum.*, **25**, *No.* 10, 1011–19 (*Oct.*, 1954).

Describes the methods and equipment developed for the irradiation of materials under controlled conditions on the 60-in. Berkeley cyclotron. Descriptions are given of the components of equipment for use in the temperature range from −195°C to 2000°C. These include target boxes which accurately locate the specimens to be irradiated in the cyclotron beam, a cold helium circulating system which is used to cool targets to about −195°C, and a servo temperature controller which automatically regulates the temperature of targets. Typical targets are described along with the conditions of irradiation. The method of determining the spatial distribution of the irradiation intensity is also given. A.

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.18.05

606. "Steric protection" of hydrophobic colloidal particles by adsorption of flexible macromolecules. W. Heller and T. L. Pugh. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1778 (*Oct.*, 1954).

Increasing concentration of polyethylene glycols increasingly protect gold sols from coagulation by KCl until an (constant) optimum is reached at 1·5 g of polymer per litre of mixture. The protective action near this optimum (e.g. at 1·00 g per litre) increases with the molecular weight of the polymer and shows a sudden and large increase at about M = 6000. W. GOOD

541.182 : 539.215.4

Errors in particle-size determination from settled suspensions. *See Abstr.* 8690 (1954)

541.182.2 : 535.43.07

A forward-angle light-scattering camera for determining size distribution in aerosols. *See Abstr.* 229

541.183

607. A statistical derivation of the B.E.T. equation. T. Keil. Letter in *J. chem. Phys.*, **22**, *No.* 9, 1617–18 (*Sept.*, 1954).

A simplified statistical-mechanical derivation of the B.E.T. equation is given, using the grand partition function, for the cases of a finite and an infinite number of adsorbed layers. It is pointed out that Hüttig's equation [*Monatshefte für Chemie*, **78**, 177 (1948)] has no physical basis. S. J. GREGG

541.183 : 535.343–15

608. Infrared spectra of chemisorbed carbon monoxide. R. P. Eischens, W. A. Pliskin and S. A. Francis. Letter in *J. chem. Phys.*, **22**, *No.* 10, 1786–7 (*Oct.*, 1954).

Graphs are given of the transmission spectra of chemisorbed CO on Cu, Pt, Ni and Pd from 4·5 to 6·0 microns. Bands are found which are attributed to CO bonded to a single metal atom for all 4 metals, and in Cu, Pt and Pd bands attributed to CO molecules bridged between two metal atoms as in iron nonacarbonyl. The spectra confirm that the CO is chemisorbed as a molecule and bonded to the metal through the C atom. A. J. TAYLOR

541.183 : 536.7

609. Thermodynamics of adsorption. R. J. Tykodi. *J. chem. Phys.*, **22**, *No.* 10, 1647–54 (*Oct.*, 1954).

The thermodynamics of the adsorption of gases on solids is developed in terms of a two-component system. It is shown that all solids swell during the adsorption process, and that spontaneous first-order phase changes in the adsorbed layer are unlikely. The ideal process: *i*(gas)→*i*(adsorbed)—constant environment—is introduced and discussed; thermodynamic functions appropriate to the process are defined. Two types of heat capacity of the adsorbed layer are defined and discussed. The chemical potential of a solid is treated at some length. A.

CHEMICAL STRUCTURE 541.2/.6

541.62 : 532.7 : 534.23

Investigation of rotational isomers with ultrasound. *See Abstr.* 133

541.65

610. Magnetic rotatory powers of some liquid ethylenic hydrocarbons. Variation with temperature. R. de Mallemann, F. Suhner and J. Grange. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 8, 571–3 (*Aug.* 23, 1954) *In French.*

The magnetic rotatory powers, rotativities, and refractivities of liquid propene, butene-1, butadiene-1, 3, pentene-1, and isoprene at various temperatures are tabulated and the mean values compared with previously recorded data on these compounds in the gaseous state [Abstr. 11519 (1954)]. The two substances containing conjugated double bonds exhibit rotativities considerably higher than the values calculated assuming additivity. G. I. W. LLEWELYN

541.653 : 539.133

611. The shape dependence of the optical anisotropy of long chain molecules. M. Čopič. Letter in *Bull. Sci. Cons. Acad. Yougoslavie*, **1**, *No.* 4, 103–4 (*Dec.*, 1953).

A formula (but not the proof) is given for the anisotropy of polarizability of the molecule chain along and at right angles to the line joining the ends of the chain (a pearl-necklace model being assumed). It is claimed to be in agreement with existing experimental data. W. GOOD

CHEMICAL ANALYSIS 543/545

545.824 : 539.166

612. Gamma absorptiometry: A new tool for analytical chemistry. M. B. Leboeuf, D. G. Miller and R. E. Connally. *Nucleonics*, **12**, *No.* 8, 18–21 (*Aug.*, 1954).

A device using a radioisotope γ-source with a

scintillation detector, to analyse samples by the absorption technique, is described. Experimental results, showing the effect of γ-energy and the type and size of phosphor employed, are given. Absorption curves for an Am^{241}–Pu^{239} source with a 2 mm thick NaI detector are shown for Al, Cu and Pb.

L. R. SHEPHERD

545.844

613. Elements of chromatography. T. I. WILLIAMS. *London, Glasgow: Blackie and Sons* (1954) 90 *pp.*

This is a "completely new book, rather than a revised edition" of the author's "An introduction to chromatography." Chapter headings are: I, Historical introduction; II, Adsorption Chromatography; III, Partition C.; IV, Ion-exchange C.; V, Miscellaneous forms of C.; VI, Treatment of colourless substances; VII, The process of development; VIII, C. in industry. In III, paper C. as well as column C. is dealt with, both for organic and inorganic compounds. In IV, the separation of rare earths is treated in some detail, and in V the application of electrophoresis to C. is touched on: in VII the distinction between frontal analysis, elution, and displacement is made clear. The book is well illustrated, with several colour plates, and has numerous practical hints, though not in great detail. It is designed to suit the needs both of students and of post-graduate research workers who require a general survey of the method as practised to-day.

S. J. GREGG

CRYSTALLOGRAPHY 548

548.24

614. Twinned crystals. R. W. CAHN. *Advances in Phys.*, **3**, *No.* 12, 363–445 (*Oct.*, 1954).

A review of experimental and theoretical work on growth twins, thermal and transformation twins and mechanical twins in metals and non-metals. Extensive bibliography.

J. FRANKS

548.5

615. Theory of crystal growth. I. V. SALLI. *Zh. éksper. teor. Fiz.*, **25**, *No.* 2(8) 208–14 (1953) In Russian.

The rate of growth of an isolated centre of crystallization is calculated for the isothermal decomposition of a supersaturated solution or for the crystallization of a single-component system. The formula derived is $dq/dt = 4\pi D(\Delta - a/r)(1/x + 1/r)r^2$, where D is the coefficient of diffusion, Δ—the difference between the concentration (c) at the outer boundary of the (spherical) zone of the solution, which becomes poorer in the solute, and that ($c\sim$) in the mother liquor for the case of plane interface, r and x—the inner radius and wall thickness of the hollow sphere involved, respectively, and $a = 2\sigma Mvc\sim/RT$, where σ is the surface tension of the growing crystal at the crystal/solution interface, M—the molecular weight of the crystallizing substance, and v—its specific volume. The analysis of causes which determine different forms of crystal growth reveals the following 3 main growth factors: (1) the growth rate varies as the true value of supercooling or supersaturation, the latter increasing as the radius of curvature of the front of crystallization increases; (2) the amount of substance, diffusing toward the front of crystallization, depends on the radius ratio of the inner and outer spheres; and (3) the increase of the difference between the two radii increases the thickness of the layer through which the substance diffuses (and heat is removed).

F. LACHMAN

548.5 : 535.323 : 537.312.6

616. On the properties of single cubic zinc sulfide crystals. S. J. CZYZAK, D. C. REYNOLDS, R. C. ALLEN AND C. C. REYNOLDS. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 864–7 (*Nov.*, 1954).

Single cubic crystals of ZnS grown by a method previously reported have been investigated for optical and electrical properties, i.e., index of refraction, optical absorption, photoconductivity, dielectric constant, and lattice parameters. The method of growing crystals has been refined over the previously reported method so that larger crystals and greater yield per individual run were obtained. Both hexagonal and cubic crystals have been grown.

A.

548.5 : 548.73

617. Polytypism of cadmium iodide. R. S. MITCHELL. Letter in *Phil. Mag.*, **45**, 1093–5 (*Oct.*, 1954).

X-ray diffraction photographs show the existence of many polytypes with different stacking sequences. This confirms Forty's ideas [Abstr. 4736 (1952)].

A. R. STOKES

548.51

618. On the effect of the crystalline orientation of iron on the surface formation of oxide nuclei at low pressures of oxygen and high temperatures. J. BARDOLLE AND J. BÉNARD. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 12, 706–9 (*Sept.* 20, 1954) In French.

See Abstr. 3193 (1951). The number of oxide nuclei formed on the surface of iron crystals held at 850°C for several hours under an oxygen pressure of 10^{-3} mm Hg varies in the ratio 100 : 1 on passing from the (100) plane to the (110) plane.

J. FRANKS

548.52 : 537.363

619. Cataphoresis of crystal nuclei. K. HIRANO; A. R. UBBELOHDE. Letters in *Nature* [*London*] **174**, 268–9 (*Aug.* 7, 1954).

The site of crystal formation in supersaturated electrolytic solutions depends on the applied electric field, indicating that charged microcrystals act as nucleation centres [see Abstr. 1355 (1950)]. Ubbelohde comments that this mechanism may cause crystalline masses to be deposited at controlled places in animal systems.

J. FRANKS

ATOMIC AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

620. Theory of thermal transitions. M. A. KRIVOGLAZ. *Zh. éksper. teor. Fiz.*, **25**, *No.* 2(8) 191–207 (1953) In Russian.

Thermal transitions of particles trapped in a crystal

lattice are treated mathematically in an adiabatic approximation, the change in the equilibrium positions of the ions during the transition being allowed for [see Kubo, Abstr. 6595 (1952), where these changes were not taken into account]. The temperature dependence of the probability w of a thermal transition is investigated. It is shown that, at sufficiently high temperatures, w is an exponential function of $1/T$, while at lower temperatures the relationship becomes more complicated. A relationship has been established between the temperature dependence of the transition probability and the position and form of the (light) absorption and emission bands caused by the admixtures. F. LACHMAN

548.7

621. Lattice dynamics of body-centered and face-centered cubic metallic elements. II. J. DE LAUNAY. *J. chem. Phys.*, **22**, *No.* 10, 1676–7 (*Oct.*, 1954).

For Pt I, see Abstr. 1856 (1954). A numerical table is presented which permits the easy calculation of the Debye characteristic temperature of any cubic metallic element at 0°K. The use of the table presupposes a knowledge of the elastic constants, atomic volume, and density of the element at 0°K. The characteristic temperature can be evaluated for either of the theoretical cases described in an earlier paper by the author. A.

548.7 : 535.375.5

Appearance of translational lattice vibrations in Raman spectra. *See Abstr.* 214

548.7 : 539.11

622. Investigations in the electron theory of crystals. S. I. PEKAR. *Berlin: Akademie-Verlag* (1954), viii + 184 *pp.* In German.

This book, a translation from a Russian original published in 1951, gives a systematic account of the author's work, carried out mainly between 1944 and 1950, on the theory of "polarons" and of localized electron levels in ionic semiconductors and dielectrics [see, e.g., Abstr. 1257 (1947); 3845 (1948); 228, 4253 (1949); 2069, 9112 (1950)]. The treatment presupposes familiarity with the elements of quantum mechanics and of the electron theory of solids. Chapter I is introductory, and contains a qualitative investigation of the electronic energy levels in a crystal with rigidly fixed ions. In chapters II and III the polaron theory is developed, the ionic motion being treated first classically and then quantum mechanically; mobility questions are treated in addition to the calculation of the energy levels. Chapters IV and V deal with the theory of F and F'-centres, the ionic motion being again treated first classically and then (for F-centres) quantum mechanically. In chapter VI the theory is compared with various experimental results, mostly relating to F-centres; electron recombination in semiconductors and the properties of PbS are also considered. An appendix contains a discussion of the paper by Fröhlich, Pelzer and Zienau [Abstr. 4053 (1950)]. The list of references contains 96 entries, mainly referring to the Russian literature. E. H. SONDHEIMER

548.7 : 539.11

The energy scheme of the system: electron–vibrating lattice. *See Abstr.* 411

548.7

623. Direct evidence for dislocation in aluminium-copper alloys. H. WILSDORF AND D. KUHLMANN-WILSDORF. Letter in *Phil. Mag.*, **45**, 1096–7 (*Oct.*, 1954).

Electron-microscope examination of the precipitate in aged alloys (Al + few % Cu) showed this to form as very closely spaced (~200 Å) similarly oriented particles along two types of rows. One of these could be interpreted as precipitates forming along the lines of a dislocation network, and the other as precipitates forming along the sequences of dislocations emitted by sources during plastic deformation. The yield stress calculated from the length and spacing of dislocations, as inferred from these observations, agrees with the experimental value. A. D. LE CLAIRE

548.7

624. Crystal defects in freshly worked surfaces. L. GRUNBERG AND K. H. R. WRIGHT. Letter in *Nature* [*London*] **174**, 657 (*Oct.* 2, 1954).

A continuation of previous work [Abstr. 575, 8442 (1953)]. The photoelectric response of abraded Al and Zn, and of evaporated Al (Kramer effect), was determined with a Geiger counter and narrow band optical filters. The emission is a maximum at 4700 Å, and is attributed to replacement of oxygen ions in the lattice of the corresponding metal oxides by pairs of electrons. Abraded surfaces on rock salt crystals, if irradiated by X-rays, are able to produce images on photographic plates. This is not due to the production of H_2O_2 as in the Russell effect, but probably results from luminescence centres emitting between 2000 and 3000 Å. S. T. HENDERSON

548.7

625. Lattice defects in ionic solids. F. G. FUMI. *Nuovo Cimento Suppl.*, **12**, *No.* 1, 67–76 (1954) In Italian.

A review of some aspects of the problem, particularly of those which are at present the object of research in Italy. L. PINCHERLE

548.7

626. On the X-ray coloration of sensitized alkali halide crystals. W. MARTIENSSEN AND H. METTE. Note in *Naturwissenschaften*, **41**, *No.* 14, 331–2 (1954) In German.

548.7

627. Production and bleaching of color centers in X-rayed alkali halide crystals. I. L. MADOR, R. F. WALLIS, M. C. WILLIAMS AND R. C. HERMAN. *Phys. Rev.*, **96**, *No.* 3, 617–28 (*Nov.* 1, 1954).

The X-ray production and optical and thermal bleaching of colour centres in NaCl and LiF have been studied quantitatively in regions of substantially uniform concentration, by making optical absorption measurements in a direction perpendicular to the axis along which the crystals were X-rayed. At room temperature F-centre growth rate for short X-ray exposures is found to be proportional to the rate of absorption of X-rays. For long exposures the rate of growth of the F-band increases greatly near the X-rayed surface. Large M-band growth accompanies this increased F-band growth. The rate of bleaching of F-centres by F light in NaCl has been studied at room temperature for low concentrations where

the light absorption is nearly uniform along the light path. Differential equations describing the rates of excitation of *F*-centre electrons to the conduction band and the trapping of conduction electrons by negative ion vacancies and holes have been integrated under special conditions. The results are found to be consistent with the experimental data. The rate of thermal bleaching of *F*-centres in NaCl has been studied at temperatures up to 150°C. It has not been found possible to analyse the data in terms of a mechanism involving trapping of conduction electrons by negative ion vacancies and holes. The results of several qualitative experiments to investigate the possible formation of vacancies during X-raying are presented. A.

548.73/.74

X-ray and electron investigation of materials. *See also under* "Structure of solids." Decimal classification 539.26/.27

548.733

628. Conversion of Norelco fluorescent spectrograph to an X-ray diffractometer. R. J. Weiss, J. J. DeMarco and G. Weremchuk. Note in *Acta Cryst.*, **7**, *Pt* 8–9, 599–600 (*Sept.*, 1954).

548.733

629. Apparatus for X-ray diffraction studies of metals under controlled stress at elevated temperature. L. S. Birks. *Rev. sci. Instrum.*, **25**, *No.* 10, 963–7 (*Oct.*, 1954).

A Geiger-counter X-ray spectrometer was constructed for the dynamic study of phase changes and other phenomena in metals under controlled stress conditions at elevated temperatures. Temperature could be controlled from room temperature to the melting point of steel, and stress was independently varied from zero stress to the breaking stress of stainless steel. Applications included isothermal and athermal transformation studies under tensile stress in pearlite, bainite and martensite. A.

548.734

630. An X-ray method of obtaining the distribution curve of lattice constants and the distribution curve of lattice orientation at the same place on a crystal specimen. E. Kappler and R. Mock. Note in *Naturwissenschaften*, **41**, *No.* 14, 330 (1954) In German.

The specimen is rotated in a monochromatic X-ray beam. The lattice-constant distribution is obtained with the film stationary; the orientation distribution by moving the film with twice the angular velocity of the specimen. A. R. STOKES

548.734

631. X-ray study of the recovery of plastically deformed aluminium single crystals. E. Kappler and R. Mock. Note in *Naturwissenschaften*, **41**, *No.* 14, 330–1 (1954) In German.

See preceding abstract. X-ray photographs are reproduced, and curves show the dependence of the half-width of the lattice-constant distribution on the annealing temperature. A. R. STOKES

548.734.8

632. Optical-diffraction methods for deducing the effects of hydrogen atoms on X-ray intensities. P. R. Pinnock and H. Lipson. Note in *Acta Cryst.*, **7**, *Pt* 8–9, 594 (*Sept.*, 1954).

Optical-diffraction methods were used to decide which reflections would be most affected by hydrogen atoms in the triphenylene structure; calculations could then be confined to these reflections.

A. R. STOKES

548.735

633. Lorentz polarization factors for precession angles of 10°, 15°, and 21°. M. Atoji and W. N. Lipscomb. Note in *Acta Cryst.*, **7**, *Pt* 8–9, 595–6 (*Sept.*, 1954).

Values, calculated from Waser's formula [Abstr. 1329 (1952)], are given as contour maps with ξ and ζ as axes. A. R. STOKES

548.735

634. Comments on probability distributions for interatomic vectors and atomic coordinates. R. K. Bullough and D. W. J. Cruickshank. Note in *Acta Cryst.*, **7**, *No.* 8–9, 598–9 (*Sept.*, 1954).

The principal results obtained by Hauptman and Karle [Abstr. 4017 (1952), 7876 (1954)] are shown to be essentially equivalent to the Patterson and Fourier methods. A. R. STOKES

548.735

635. On the substantialization of sign sequences. I. J. Good. Note in *Acta Cryst.*, **7**, *Pt* 8–9, 603–4 (*Sept.*, 1954).

It is shown how Woolfson's method [Abstr. 2888 (1954)] of finding signs of structure factors may be generalized, and in particular how 2048 sequences of 15 signs may be found, such that one of these sequences has not more than one sign wrong. A. R. STOKES

548.736.3

636. The lattice spacings of binary tin-rich alloys. J. A. Lee and G. V. Raynor. *Proc. Phys. Soc.* [*London*] *B*, **67**, *Pt* 10, 737–47 (*Oct.*, 1954).

The variation with composition of the lattice spacings of the solid solutions in tin of antimony, bismuth, lead, indium, cadmium, zinc and mercury has been determined. Antimony and bismuth decrease the axial ratio of white tin, while the other elements investigated increase the axial ratio. This suggests that the Brillouin zone for white tin is overlapped across planes of energy discontinuity which lie parallel to the tetragonal axis; the most probable form of this zone is discussed. The suggested Brillouin zone is bounded by planes of the (220) and (211) families, of which only the former are overlapped. The axial ratio variations may then be interpreted, and a possible explanation given for anomalies in the lattice spacing–composition curves for tin–indium and tin–cadmium alloys, which are associated with the development of vacant lattice sites. A.

548.736.5

637. The lattice constants of the mixed oxides of cobalt and manganese at various temperatures. I. Aoki. *J. Coll. Arts Sci. Chiba Univ. Nat. Sci. Ser.*, **1**, *No.* 3, 150–2 (*March*, 1954).

Axial ratios and electrical resistivity of specimens with varying proportions of CoO in Mn_3O_4, some of them quenched from 500°C and 700°C, are given. The

resistivity is a minimum (5Ω-cm) for Co_1Mn_2 oxide, the structure of which is probably inverse spinel.

R. S. PEASE

548.737

638. The crystal structure of paradichlorobenzene. B. C. Lutz. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1618 (*Sept.*, 1954).

A discontinuity in the temperature dependence of the nuclear quadrupole resonance absorption line of the chlorine nucleus at 35 Mc/s suggests a phase change. The Zeeman splitting shows the high-temperature phase to contain aligned C–Cl bonds, whilst the other phase showed a less well defined Zeeman pattern. A. J. TAYLOR

548.737 : 535.347

639. Infrared evidence for collagen structures. G. B. B. M. Sutherland, K. N. Tanner and D. L. Wood. *J. chem. Phys.*, **22,** *No.* 9, 1621 (*Sept.*, 1954).

Previously a model for collagen was suggested by Crick [Abstr. 6143 (1954)] which was based on X-ray analysis. Here the dichroism of collagen is investigated between 5000 and 600 cm^{-1}, and the results are compared with predictions based on this model. It is found that, although the 3300 and 4590 cm^{-1} bands show perpendicular dichroism, as predicted, the dichroic ratio is higher for CO than for NH stretching, which does not agree with the model. The dichroism at 650 cm^{-1} is found to be weak and perpendicular instead of strong and parallel. There are also discrepancies in the 4850 and 1550 cm^{-1} bands. This model is therefore incompatible with the dichroism measurements. A. J. TAYLOR

548.737 : 535.347

640. Dichroism of the crystal of diformylhydrazine. S. Yamada and R. Tsuchida. Letter in *J. chem. Phys.*, **22,** *No.* 9, 1629 (*Sept.*, 1954).

Although nitrogen usually tends to form tetrahedral bonds, the molecules of this compound are planar in the crystal. Therefore the bonds may have considerable π-character. Anisotropy of light-absorption can be expected. Crystals were investigated in the visible and u.v. regions. Measurements were taken on the (110) plane with polarized light having the electric vector perpendicular to $(20\bar{1})$. Two absorption bands were found, one due to conjugated π-bonds, the other corresponding to the 2100 Å band of benzene. For the π-bond, parallel absorption is hyperchromic and slightly bathochromic to perpendicular absorption. A. J. TAYLOR

548.737 : 539.133

Structures of molecules and crystals of fluorocarbons. *See Abstr.* 438

548.74

641. Interference-refraction of electron beams. II. The fine structure of the diffraction pattern of MgO crystals. K. Molière and H. J. Altenhein. *Z. Phys.*, **139,** *No.* 1, 103–14 (1954) In German.

Pt I [Abstr. 8799 (1954)] gave a theoretical explanation of the fine structure of electron diffraction spots first observed by Cowley and Rees [Abstr. 1881 (1947)]. The explanation relies upon the dynamic theory of diffraction of von Laue and involves a refraction of the electron beam owing to the inner potential of the crystal. An experimental test of the theory has now been carried out, with the ultimate aim of investigating how far quantitative data could be obtained on the refraction effects and whether values could be obtained for the Fourier coefficients of the crystal potential. The diffraction technique has been improved, particularly by employing the very small illuminating apertures ($1 \cdot 3 \times 10^{-5}$) obtainable with an electron gun of the type used in electron microscopy, so that spots showing well-defined substructure can be readily obtained. The results obtained from smoke particles of MgO and CdO are found to agree satisfactorily with theory. Quantitative discussion of the refraction effects is reserved for a subsequent paper. V. E. COSSLETT

548.74

642. Electron diffraction by electropolished surfaces and mean inner potentials of silver and copper. S. Yoshida. Note in *Acta Cryst.*, **7,** *Pt* 8–9, 592–3 (*Sept.*, 1954).

From electron diffraction measurements carried out on electropolished surfaces of single crystals of Cu and Ag determinations are made of the mean inner potential and the angles between the minute facets on the crystal surface and the crystal surface itself. J. THEWLIS

548.74 : 537.533.73

643. The radiation field [produced] by electron diffraction at the exit face of a crystal. H. Niehrs. *Z. Phys.*, **138,** *No.* 5, 570–97 (1954) In German.

A mathematical treatment of the phenomenon, occasionally observed in electron microscope photographs of small single crystals, of the occurrence of regular striations parallel to the edges of the crystals. The results are compared with those found experimentally. J. THEWLIS

548.74 : 537.533.73

644. Double interference of electrons with extinction of the third wave front. H. Niehrs. *Z. Phys.*, **139,** *No.* 1, 88–102 (1954) In German.

The theoretical explanation of certain broad interference bands observed in electron micrographs (e.g. of MgO crystals) indicates that they arise from double interference, i.e. from two separately reflected beams, rather than from superposition of the initial and a singly reflected beam. However, the dynamical theory of diffraction requires the formation of three wave fields in such a case, which would not in general give rise to regular interference bands parallel to the diffracting crystal edge, as observed. The present work shows that over certain ranges of orientation of the crystal with respect to the incident beam, the third wave field may be completely extinguished, leaving only two emergent beams to form the interference bands. The consequences are explored for the substructure of spots in electron diffraction patterns as well as for the electron microscopy of crystals. The treatment is an extension of that in a previous paper by the author on the same subject (preceding abstract). V. E. COSSLETT

GEOPHYSICS 55

550.385 : 537.591

On the behaviour of cosmic rays in magnetic storms. *See Abstr.* 357

550.93

645. The age of the earth and the universe. F. G. HOUTERMANS. *Nuovo Cimento Suppl.*, **12,** *No.* 1, 17–25 (1954) In Italian.

A study of the data for isotope abundance in minerals of the radioactive elements and in particular lead, has produced a figure of $(4{\cdot}5 \pm 0{\cdot}4) \times 10^9$ years as a best estimate of the age of the earth from this source. J. M. HOUGH

551.16

646. Composition of the Earth's outer core. K. E. BULLEN. Letter in *Nature* [*London*] **174,** 505 (*Sept.* 11, 1954).

With the help of recently revised astronomical data the following four postulates, which were discussed by the author and other investigators on previous occasions, are re-examined: (*a*) Earth, Mars and Venus have a common primitive origin; (*b*) compressibility is a smoothly varying function of pressure, in all three planets, beyond 0·4 million atmospheres; (*c*) the outer core of the Earth is a high-pressure modification of ultrabasic rock; (*d*) each planet has an inner core chemically distinct from the matter in the outer core. Various modifications are now indicated; it appears, e.g. still possible by a suitable change of (*c*) to reconcile seismic and astronomical data with the hypothesis (*a*); but there remain difficulties concerning the Moon and particularly Mercury. A. BEER

ATMOSPHERE . METEOROLOGY 551.5

551.508.1 : 536.531

647. Thin-wire thermometer for radiosondes. J. PICCARD, H. LARSEN AND J. BLOMSTRAND. *Rev. sci. Instrum.*, **25,** *No.* 10, 959–63 (*Oct.*, 1954).

It is shown that the thinner the thermometer element of a sounding balloon, the smaller the errors due to radiations from the sun and the earth. A thin wire thermometer made from white gold wire as described was delivered in 1941 to the U.S. Weather Bureau. The instrument sends off its findings by radio signals in Morse code. A very efficient vibration absorber for the instrument is described. A.

551.510.535

648. The lower *E* and *D* region of the ionosphere as deduced from long radio wave measurements. R. J. NERTNEY. *J. atmos. terrest. Phys.*, **3,** *No.* 2, 92–107 (*Feb.*, 1953).

The best working model so far constructed of the *D* and *E* regions is described, and the predictions it gives are compared with the following available experimental data: virtual height of reflection on 16 kc/s and 150 kc/s, diurnal variation of absorption on 150 kc/s and vertical incidence reflection coeff. on 16 kc/s, frequency variation of absorption, diurnal variation of the angle of tilt of the polarization ellipse on 150 kc/s, winds measured at 150 kc/s, and the effect of a S.I.D. G. M. BROWN

551.510.535

649. A note on the "sluggishness" of the ionosphere. E. V. APPLETON. Note in *J. atmos. terrest. Phys.*, **3,** *No.* 5, 282–4 (*June*, 1954).

Two methods of determining the quantity αN for a layer, where N is the electron density at noon and α the recombination coeff., are described. One depends on the diurnal trend of some quantity which is proportional to N, the other on the delay time between the diurnal maximum of N and noon (which is shown to be $1/2\alpha N$ sec). Both methods give consistent values of αN for the *D*-region. The daytime range of αN from the *D* to the *F*2-layer is remarkably small, with a maximum in the *E*-layer. G. M. BROWN

551.510.535

650. Electron distribution in the ionosphere. G. A. M. KING. Note in *J. atmos. terrest. Phys.*, **5,** *No.* 4, 245–6 (*Sept.*, 1954).

Indication of a method for calculating true ionospheric heights from virtual height/frequency records. It may be used to include the effect of the earth's magnetic field, and should be considered in conjunction with Kelso's method [*J. geophys. Res.*, **57,** No. 3, 357 (Sept., 1952), and Abstr. 11614 (1954)]. G. M. BROWN

551.510.535

Radio-wave propagation in the ionosphere. See also under "Electromagnetic waves and oscillations." Decimal classification 538.566.3

551.510.535 : 537.568

Recombination rates of O_2^+ ions in the *D*-layer. *See Abstr.* 355

551.510.535 : 550.385

651. The charge on the ionosphere. J. A. CHALMERS. Note in *J. atmos. terrest. Phys.*, **3,** *No.* 6, 345–6 (*July*, 1953).

Assuming that conduction is the only process of transfer of electricity above clouds it is shown that the total charge on the inner side of the ionosphere is zero, so that upward positive currents ($\sim$0·5 A) above storm clouds must be balanced by equal and opposite downward currents above fine weather areas. The undisturbed vertical field at the earth's surface thus varies as the total number of active storms. G. M. BROWN

551.510.535 : 551.594.5

652. The association of pulsating and flaming auroras with complete ionospheric absorption at Macquarie Island. G. MAJOR. *Austral. J. Phys.*, **7,** *No.* 3, 471–6 (*Sept.*, 1954).

Records of simultaneous auroral observations and ionosphere soundings at Macquarie Island (geomagnetic lat. $-61{\cdot}7°$) show that pulsating or flaming auroras are frequently accompanied by complete absorption of the vertically incident waves. However, the nocturnal variations of frequency of occurrence of these two phenomena are markedly different in form. A.

551.510.535 : 551.594.5

653. Electron density in the *E*-layer during auroral displays deduced from measurements of absolute brightness of the auroral luminosity. A. OMHOLT. Note in *J. atmos. terrest. Phys.*, **5**, *No.* 4, 243–4 (*Sept.*, 1954).

Measurements of the absolute intensity of the auroral negative nitrogen bands (4278 Å) with a photomultiplier enable the electron density to be calculated if it is assumed that the operative process for both ionization and excitation is entirely $N_2 + X \rightarrow N_2^{+\prime}(B) + e + X$. Results, given for various auroral forms, are in the range $10^6 - 10^7$ electrons/cm^3, assuming a recombination coeff. of 10^{-8} cm^3 sec^{-1}. G. M. BROWN

551.511 : 530.162

654. Statistical thermodynamics of the vertical temperature gradient of the atmosphere. H. ERTEL. *S.B. Dtsch. Akad. Wiss. Berlin, Kl. Math. Nat.*, **1953**, *No.* 4, 14 *pp.* (*publ.* 1954) In German.

The paradox introduced by the theory of Schmidt [*Meteorologische Zeitschrift, Braunschweig L*921, 262–68] is shown to be due to the assumption that the small air masses all have the same temperature gradient of thermodynamic change of state. It is now assumed that in fact they are stochastically coupled and new expressions are derived which remove the paradox. J. M. HOUGH

551.578.1 : 523.53

655. The influence of meteoric dust on rainfall. E. G. BOWEN. Note in *Austral J. Phys.*, **6**, *No.* 4, 490–7 (*Dec.*, 1953).

Comments on a paper by E. G. Bowen. 1. W. C. SWINBANK. *Ibid.*, **7**, *No.* 2, 354–8 (*June*, 1954).

Comments on a paper by E. G. Bowen. 2. D. F. MARTYN. *Ibid.*, **7**, *No.* 2, 358–64 (*June*, 1954).

Fluctuations of long-period accumulations of daily rainfall amounts. J. NEUMANN. *Ibid.*, **7**, *No.* 3, 522–6 (*Sept.*, 1954).

The coincidence in northern and southern hemispheres of days of abnormal rainfall leads Bowen to postulate extraterrestrial causes, in particular, the nucleation of rain clouds by meteoric dust. The other three authors give reasons for scepticism, and attribute the coincidence to random causes.

551.593.5

656. A note on the role of multiple scatterings in the luminance of the sky. J. LENOBLE. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 5, 409–11 (*Aug.* 2, 1954) In French.

A theoretical calculation to show that the effect of repeated scattering causes a geometric progression in intensity independent of wavelength to a first order of approximation. J. M. HOUGH

551.593.5

657. The color of the overcast sky. W. E. K. MIDDLETON. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 793–8 (*Oct.*, 1954).

A theory is developed for the spectral irradiance of the overcast sky, and also of the top of the overcast, in terms of incident radiation, droplet size and concentration, and cloud thickness. The absorption of light by cloud water is allowed for. Some samples of highly polluted cloud water have been spectrophotometered, and calculations made which show that the absorption produces very little effect in the visible spectrum, and only a moderate effect in the ultraviolet, even for very impure cloud water. On the other hand, the colour of the ground has a considerable effect on the spectral irradiance of the overcast sky, and thus on its colour. The colour of the top of the overcast is, however, not greatly affected by that of the ground. A.

551.593.9 : 537.591.8

Contribution to night sky illumination of the Cherenkov radiation from cosmic ray showers. *See Abstr.* 377

551.594.14

658. The radon content of the atmosphere. W. ANDERSON, W. V. MAYNEORD AND R. C. TURNER. *Nature* [*London*] **174,** 424–6 (*Sept.* 4, 1954).

Measurements were first made by drawing 10 000 litre air samples through filter papers and assaying their activity with an end-window Geiger counter. Comparison with whole-air measurement using a 3-litre ion chamber and an electrometer showed that under fine weather conditions the radon content in London is $2–3 \times 10^{-13}$ curies/litre, but that the filter paper method shows only a few per cent of this activity. Measurements with the filter paper during fog show increasing activity with increasing weight of solid matter collected. The activity during the London "smog" of 1952 was 8×10^{-13} c/l, but as no comparison with the ion chamber has been made under fog conditions the correction factor is unknown; the fine weather factor would give the "smog" activity as 4×10^{-11} c/l. The possibility of some of the atmospheric radon being derived from the burning of coal and coal-gas is being investigated and activities are quoted for some combustion products. L. E. MUSSELL

551.594.221

659. An analysis of the electric field after lightning discharges. Y. TAMURA. *J. Geomagn. Geoelect.*, **6**, *No.* 1, 34–46 (*March*, 1954).

A typical difference is pointed out in the recovery curves of the earth's electric field after lightning flashes at different distances from the point of observation. In an attempt to explain these curves a mathematical derivation is presented of the field change curves under the assumption of a vertical pos. dipole to represent the cloud charges, a constant rate of charge separation, and an exponential increase in the conductivity of the air. It is shown that the resulting variation of the field strength with time can be expressed as the sum of 3 components, the physical significance of which is discussed. Several numerical examples are evaluated and these show good agreement with observational results. The effect is discussed of variations of the parameters on which the calculation is based. R. H. GOLDE

551.594.5

660. Variations of intensity of the aurora at Macquarie Island. F. JACKA. *Austral. J. Phys.*, **7**, *No.* 3, 477–84 (*Sept.*, 1954).

Observations of intensity of the aurora at Macquarie Island (geomagnetic co-ordinates 61°S, 243°E) are examined. The intensity is found to be dependent on geomagnetic planetary disturbance index K_p, but the form of this dependence is different for different auroral forms. After eliminating the effects of variation of K_p the residual diurnal and annual variations of intensity are small and irregular. A.

BIOLOGY 57/59

577.15.035

661. Modification of the carbon arc searchlight for producing experimental flashburns. T. P. Davis, L. J. Krolak, R. M. Blakney and H. E. Pearse. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 766–9 (*Oct.*, 1954).

During the past five years, a carbon arc source, which is basically a 24 in. Corps of Engineers searchlight with the standard parabolic mirror replaced by an ellipsoidal reflector, has been developed for use in a study of radiant energy burns in experimental animals. Accessory equipment has been devised which permits control over irradiance and exposure time, with a maximum irradiance of about 31·8 cal/cm²-sec, and a minimum exposure time of 0·1 sec. This report describes the source and its operational characteristics. A.

591.111.4 : 532.13

662. Apparatus for measuring relative blood viscosity. R. L. Swank and J. G. Roth. *Rev. sci. Instrum.*, **25**, *No.* 10, 1020–2 (*Oct.*, 1954).

A method for measuring blood viscosity which can be applied to small quantities of blood containing no anticoagulant, and which can be repeated at several minute intervals is described. The method utilized an old principle of measuring time of flow of a fixed quantity of blood (0·1 cm³) through a fixed capillary tube (hypodermic needle with a bore approximating 0·3 mm), using a fixed negative pressure of 100 mm of mercury. The needle and pipette which come into contact with the blood are maintained at a temperature of 37°c ± 0·5°c. The blood is drawn into a 2 cm³ siliconed syringe through a size 20 siliconed intravenous needle. The calibrated capillary tube is then inserted through the tip of the syringe and negative pressure applied. The time of flow is measured with a stop clock to 0·1 sec. Duplicate measurements on the same sample of blood can be made in less than 30 sec. A high vacuum pump is included with the apparatus to clean and dry the needles and calibrated pipette immediately after each measurement. The relative viscosity of the blood is then computed by dividing the time for flow of 0·1 cm³ of blood by the time for flow of water at the same temperatures. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.841

663. A masking technique for isolating the pupillary response to focused light. J. M. Fugate. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 771–9 (*Oct.*, 1954).

Two methods were used; one employed flash stimuli of various sizes on a dark background and the other employed a masking technique. An infrared photographic technique was used for recording changes in pupil diameter in response to the stimulus conditions used in this study. When using the 51° flash stimulus, it was hoped that enough photoreceptors would be included in the area of focused light to elicit a pupillary response before the stray light would become intense enough to produce a response. In the masking technique the retina was adapted to a centrally fixated stimulus for four to six seconds and then a one-second flash stimulus 15° in diameter or less was superimposed upon it. The purpose of the adapting stimulus was to mask the pupillo-motor effect of the stray light from the flash stimulus. Data for the flashes of various sizes on a dark background support the hypothesis that stray light is the main determinant of the pupillary response in this situation. However, when a 51° flash stimulus was used, a response to focused light was evident at low levels of luminance. In general the masking technique was successful in masking the pupillary response to stray light when used with flashes of low luminance. The visual and pupillary thresholds were shown to be about the same in this investigation. It is recommended that the masking technique used in this study be used to study summation and the pupillo-motor sensitivity of different parts of the retina. A.

612.843

664. Physical measures of stray light in excised eyes. R. M. Boynton, J. M. Enoch and W. R. Bush. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 879–86 (*Nov.*, 1954).

A technique is described whereby it is possible to measure, by a direct physical method, stray light in the excised eye of the cat, steer and human. Systematic changes in the measures obtained are noted as a function of time following removal. When time correction factors, based on a cat eye, are applied to cat, steer and human data, no significant difference in the distribution of stray light in the eyes of the three species is obtained. Experiments with steer eyes lead to the conclusion that the principal component of stray light is scatter. The results of this research are compared to those of three studies where estimates of intraocular stray light were based on psychophysical judgments of the effects of glare stimuli. It is concluded that there is more than enough stray light in the human eye to account for these effects. The discrepancy is attributed mainly to the directional sensitivity of the cones. A.

612.843.31

665. A graphical interpretation of a three-components theory of chromatic adaptation in terms of the CIE chromaticity diagram. G. Wyszecki. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 787–92 (*Oct.*, 1954).

The effect of changed chromatic adaptation of the eye under source *A* (incandescent-lamp light), as compared with its adaptation under source *C* (average daylight) has been approximately explained by Helson, Judd and Warren by means of a form of three-components theory. By this theory, each object-chromaticity point (x, y) for source *A* determines a corresponding object-chromaticity point (x', y') from which the predicted chromaticness (hue and saturation) of the colour perception is read by interpolation in the Munsell renotation system. The present paper gives a geometrical interpretation of the theory directly in terms of the C.I.E. chromaticity diagram,

whereby without any computation it is possible to find the corresponding object-chromaticity point (x', y'). The basic data for such an interpretation are given, not only for adaptation to source A, but also for adaptation to any source whatever. A.

612.843.611

666. Selective adaptation of components of the human electroretinogram. J. C. ARMINGTON AND F. C. THIEDE. *J. Opt. Soc. Amer.*, **44**, *No.* 10, 779–86 (*Oct.*, 1954).

The effects of coloured adaptation stimuli upon the photopic X-wave and the scotopic B-wave components of the human electroretinogram have been investigated. An experimental arrangement was adopted in which the eye was exposed continuously to a coloured central field together with a surrounding white adaptation field. Relative spectral sensitivity of the electroretinogram was determined for various combinations of surround luminance and central field colour. With a dim surround luminance (0·006 ft-L) both X waves and B waves were clearly present in the electrical recordings. Red central adaptation reduced sensitivity of the X wave while blue adaptation reduced sensitivity of the B wave. With a more intense surround luminance (2 ft-L) a single wave form was observed, but its sensitivity could be reduced in limited spectral regions through the use of appropriate colour adaptations. The data indicate that either the X wave or B wave may be selectively reduced in amplitude if the eye is adapted to light for which one or the other components possesses greater sensitivity. They further indicate that specific adaptation effects may be produced in the isolated photopic component alone. A.

612.843.611

667. Location of the break in the dark adaptation curve in relation to pre-exposure brightness and pre-exposure time. E. WOLF AND M. J. ZIGLER. *J. Opt. Soc. Amer.*, **44**, *No.* 11, 875–9 (*Nov.*, 1954).

Dark adaptation curves are obtained by presenting a 2° square testfield, subdivided by vertical bars, 6° in the lateral parafovea. When pre-exposure time is constant (10 min), and pre-exposure brightness is progressively decreased, the cone plateau gradually drops to lower brightness levels, while the final rod level remains constant. However, when pre-exposure brightness is constant (1510 millilamberts), and pre-exposure time is varied, the cone plateau and the final rod level remain unchanged. The break in the duplex curve shifts to earlier times with decreasing pre-exposure brightness as well as with decreasing pre-exposure time. Linear relationships exist between time of appearance of the break (minutes) and log pre-exposure brightness, or log pre-exposure time. The slope constants are different, however, indicating that pre-exposure brightness and pre-exposure time are not reciprocally interchangeable as far as the location of the break is concerned. A.

612.85

668. Some factors affecting multi-channel listening. J. P. EGAN, E. C. CARTERETTE AND E. J. THWING. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 774–82 (*Sept.*, 1954).

Certain factors were investigated that affect the intelligibility of a speech message which is presented to a listener simultaneously with an interfering speech message. In two of the four experiments reported, filters were introduced into one of the two channels that carried the messages. Thresholds of perceptibility were not reliably decreased by moderate amounts of filtering of the received message. However, articulation scores were considerably increased by the use of a high-pass filter (500 c/s) in either of the two channels. The great advantage of presenting one message to one ear and the interfering message to the other ear (dichotic presentation) was measured by changes in the thresholds of perceptibility and by articulation tests. Functional relations between thresholds of perceptibility for the message to be received and the intensity of an interfering signal were determined for both monaural and dichotic listening. In separate tests, noise was also used as the interfering signal. Dichotic reception permits a reduction in intensity of the received signal of about 30 db as compared with monaural reception. Articulation-gain functions demonstrated a similar advantage for dichotic over monaural listening. When the message to be received and the interfering message are monaurally received at equal intensities, the articulation scores for the designated messages are about 50%. If the message to be received is somewhat less intense than the interfering one, the cue value of the intensity difference offsets the increased masking of the less intense by the more intense message. A.

612.85 : 534.321

669. Observation of the Tartini pitch produced by $\sin 11x + \sin 15x$ and $\sin 11x + 2 \sin 15x$. M. F. MEYER. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 759–61 (*Sept.*, 1954).

The result of experiments with sinusoidal airwaves is that the ratio 11 : 15 makes the Tartini pitch 7 clearly audible, while neither a summation tone pitch nor a difference tone pitch nor any kind of aural harmonic is audible. A.

612.85 : 534.321

670. Tartini *versus* Helmholtz judged by modern sensory observation. M. F. MEYER. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 761–4 (*Sept.*, 1954).

Concerning the frequency location and the origin of the Tartini pitches the dogmatic assertions found in the textbooks of psychophysiological acoustics are the unhappy evolution of the hopeful guess ventured by Helmholtz that these secondary pitches and the physical combination tones produced by an air pressure tank could be regarded as analogous. In fact, they are incompatible. A.

612.85 : 534.321.5

671. Unison tuning of musical instruments. J. F. CORSO. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 746–50 (*Sept.*, 1954).

Deals with two factors related to the unison tuning of musical instruments: (1) the harmonic structure of the reference tone, and (2) the method of presentation of the reference tone during the tuning process. Data are presented on the accuracy of tuning four different instruments in unison with five reference-tone waveforms under simultaneous and successive tuning conditions. The results indicate that neither harmonic structure nor method of presentation of the

reference tone has a significant effect upon tuning accuracy. The hypothesis is offered that unison tuning of musical instruments is dependent upon pitch-matching judgments rather than the discrimination of beats, as classically stated. A.

612.85 : 534.321.5

672. Pitch shifts accompanying certain auditory threshold shifts. J. C. WEBSTER AND E. D. SCHUBERT. *J. Acoust. Soc. Amer.*, **26**, *No.* 5, 754–8 (*Sept.*, 1954).

A method was developed for getting a continuous and running record of pitch matches between the two ears, using (1) the synchronized frequency- and paper-drive features of a "Bekesy" type audiometer and (2) the subject's adjustment of the frequency knob of a second oscillator to drive the recording pen. A one-second tone from the motor-driven (standard) oscillator (controlling the paper drive) is presented to one ear and a two-second tone from the subject's (variable) oscillator (controlling the pen writing mechanism) is presented alternately to the other ear. The subject, who controls the frequency of the variable tone, is instructed to keep the two alternating tones matched in pitch. Ten music students made these pitch matches (90 matches per octave) from 150 to 9600 c/s. In the ear in which the standard tone was heard various types and amounts of hearing loss were simulated by masking noises. The pitch tended to shift away from a region of hearing loss to a region of no, or less, hearing loss. Downward shifts were observed but were never as marked as the upward shifts. A.

TECHNIQUE. MATERIALS 62/69

669 : 534.321.9

Metallurgical effects of ultrasonic waves. *See Abstr.* 140

PHOTOGRAPHY 77

771.53

673. On the resolving power of the photographic image with special regard to the developer. N. HANSSON. *Ark. Astron.*, **1**, *Paper* 35, 531–42 (1954).

The test object consisted of line patterns. The camera objective was used at its experimentally determined optimum aperture for resolution (*f*/6), and exposures were arranged to give standard blackening of the negatives. Colour filters allowed the effects of red, green and blue light to be compared; 17 developers and 3 plate types were used. No appreciable correlation was found between resolving power and (1) the Eberhard and Kostinsky effects, or (2) different developers, other than surface developers. The influence of colour was greatest for thick emulsions, where a decrease in resolution occurred for green light. An annotated bibliography is given (46 refs.).

S. T. HENDERSON

771.534 : 548.7

674. The vacuum photolysis of silver bromide. G. W. LUCKEY. *J. phys. Chem.*, **57**, *No.* 8, 791–6 (*Nov.*, 1953).

The photolysis of silver bromide crystals, slabs and evaporated films in vacuum has been studied by measuring the pressure of the photolytic bromine. The quantum yields at 27° were independent of intensity in the range extending from about 10^{14} to 10^{16} quanta/sec/cm^2. The quantum yields increased with decreasing wavelength in the region extending from 280 to 436 mμ at 27°. Increasing the temperature decreased the quantum yields at all wavelengths, but the decrease was greater at short wavelengths. Bromination and evacuation of previously irradiated samples at 200° either did not affect or decreased the room temperature quantum yield at 365 mμ. In general, the quantum yield of evaporated films increased with exposure at 365 mμ, while the yield of fused samples remained constant or decreased slightly. The maximum decomposition in the experiments was about 0·1%. The data indicate that vacuum is a good halogen acceptor and that the quantum yield of the silver bromide decomposition is near unity when the concentration of electron traps is high enough. In the relatively thick crystals studied, the decomposition which produced measurable quantities of bromine occurred in a thin surface layer. At high temperatures, the trapped electrons are not stable and some recombination with positive holes occurs. A.

771.534 : 548.7

675. The effect of impurities on the optical sensitization of the photographic emulsion. W. WEST AND B. H. CARROLL. *J. phys. Chem.*, **57**, *No.* 8, 797–801 (*Nov.*, 1954).

At least two general types of impurity effects can be recognized in the silver halide photographic system: (1) the general level of sensitivity is governed by impurities in the silver halide surface derived from digestion of the grains with labile sulphur compounds during the ripening process, and (2) the sensitivity to long wavelengths conferred by dyes can, in certain circumstances, be greatly increased (supersensitization) or decreased (antisensitization) by the presence of small amounts of foreign dyes or similar compounds. The action of the first type of impurity centres round the trapping of electrons and positive holes, and the build-up of latent image, while that of the second seems to depend on the trapping of electronic excitation energy (excitons) in a co-operative layer of adsorbed dye molecules and on influencing the probability of transfer to the halide. Details and examples are given of the phenomena of supersensitization and antisensitization, in which it is shown that these effects are particularly marked in sensitizers showing the sharp absorption bands which, according to Franck and Teller, may represent exciton motion. A mechanism of the phenomena is suggested based on the hypothesis of propagation of excitation energy throughout the co-operative layer and its trapping and transfer to silver halide at the singularity represented by a supersensitizer molecule

and its trapping and degradation at the singularity represented by an antisensitizer molecule. A.

771.534 : 548.7

676. Sensitization of X-ray emulsions by very small quantities of a lead salt. E. T. LARSON, F. W. H. MUELLER AND H. HOERLIN. *J. phys. Chem.*, **57**, *No.* 8, 802–8 (*Nov.*, 1953).

Divalent lead ions were coprecipitated with the silver bromide crystals of a photographic emulsion which was made with a relatively inert photographic gelatin. The average grain size and the width of the grain size distribution decreased with increasing lead concentration; 0·2 mole per cent lead (based on silver ion) produced an extreme reduction in grain size and photographic sensitivity to X-rays and light, thus setting an upper limit to the concentrations which are of practical importance. Lead concentrations of about 0·05 mole per cent increased the X-ray sensitivity of ripened emulsions 80%; the effect was only slightly dependent on X-ray energy, being least for high energies. For unripened emulsions, lead concentrations of 0·001 to 0·04 mole per cent increased the X-ray sensitivity about 40% for 10 and 65 kV X-rays and a negligible amount for radium γ-rays. The sensitivity to light of the ripened emulsions was unaffected by lead in concentrations up to 0·04 mole per cent. The unripened emulsions exhibited unusual reciprocity law characteristics which were extremely susceptible to change with age and with the addition of lead. It is postulated that the effect of lead in increasing X-ray sensitivity is due to the increase in the number of silver ion vacancies in the crystal lattice, the vacancies acting as traps for positive holes, and/or that increased silver ion mobility results from the silver ion vacancies which are generated in number equal to the number of lead ions. Preliminary tests indicate that divalent cadmium ions produce similar increases in X-ray sensitivity. A.

771.535

677. Changes in the latent image before development. I. Theoretical treatment. M. T. VIGÓN, M. A. DE LA VEGA AND M. SOLÍS. *An. Real Soc. Españ. Fis. Quím.*, **50(A)** *No.* 3–4, 71–88 (*March–April*, 1954) In Spanish.

An equation is set up which expresses the variation of the latent image as a function of the time which elapses between the exposure of the emulsion and its development. It is claimed that all conclusions derivable from this equation which could be tested experimentally are valid. Nevertheless, the influence of oxygen on the grains during the storage period can be so great that secondary oxidation processes can be the most important cause of variation in the latent image. The equation should be regarded as an approximate expression of a general law describing the process, as in its deduction it has been assumed that the transition of an unstable centre in the latent image to a stable state takes place instantaneously, a hypothesis which is questionable but which leads to simple results in accord with experiment. A. L. MACKAY

772.5

678. Experimental photographic systems based on phosphotungstic acid. L. CHALKLEY. *J. Opt. Soc. Amer.*, **44**, *No.* 9, 699–702 (*Sept.*, 1954).

The heteropolytungstic acids, especially certain of the phosphotungstic and silicotungstic acids, are photo-oxidizing agents with properties that suggest their use in photographic processes. The chemical and physical properties of the substances are described, and simple demonstrations of three new photographic processes based upon phosphotungstic acid are outlined. These comprise a printing out process producing images in pigments of basic dyes; phototropic, and therefore reusable, printing out materials; and the development of a latent image. A.

778.33

679. Resolution and sensitivity considerations in autoradiography. L. F. LAMERTON AND E. B. HARRISS. *J. photogr. Sci.*, **2**, *No.* 4, 135–44 (*July–Aug.*, 1954).

778.34

680. Concerning the shrinkage factor of a nuclear emulsion. J. FERNÁNDEZ FERRER AND M. PUJAL CARRERA. *An. Real Soc. Españ. Fis. Quím.*, **50(A)** *No.* 7–8, 151–4 (*July–Aug.*, 1954) In Spanish.

In measuring the tracks of mono-kinetic α-particles, Horan [Abstr. 7369 (1953)] found an increase of the apparent length when the inclination of them is increased, showing the possibility of a non-uniform shrinkage. The authors have now determined a shrinkage factor of a NTA plate at different depths, finding that it follows a regular variation which is very approximately parabolic. A.

778.34

681. Device for accurate location of events in nuclear emulsion. J. OREAR. *Rev. sci. Instrum.*, **25**, *No.* 9, 875–6 (*Sept.*, 1954).

A scale with 100 μ fine divisions and 1000 μ coarse divisions is pressed into the emulsion by rolling a fine toothed wheel across the emulsion. The position of the fine division on a 10 by 10 rectangular grid reticle (whipple disk) can be recorded to within 1 μ accuracy. This permits quick repositioning of events and strips with 1 μ accuracy independent of the accuracy of the stage motion. A.

778.34

682. Variation of the sensitivity of nuclear emulsions as a function of temperature. G. ALVIAL C. *Nuovo Cimento*, **12**, *No.* 3, 351–7 (*Sept.*, 1954) In Italian.

The variation between 20 and 90°C was measured by means of the change in the average grain density of tracks of α-particles of 4·18 MeV. Density variation of fog as a function of temperature is also given. Two maxima of sensitivity were found: one at about 30°C; the other at about 70°C. A.